1889, Mar. 14 – 1891, Oct. 21.

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Third Series.

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PROCEEDINGS

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THE ROYAL IRISH ACADEMY.

PAPERS READ BEFORE THE ACADEMY.

I.

FURTHER NOTES ON THE IDENTIFICATION OF THE ANIMALS AND PLANTS OF INDIA, WHICH WERE KNOWN TO EARLY GREEK AUTHORS. By V. BALL, M.A, F.R.S., Director of the Science and Art Museum, Dublin.

[Read May 23, 1887.]

IN the present communication I propose to deal—but by no means exhaustively, and perhaps not finally—with some further information which I have acquired in support of the identifications given in my original Paper[1] on this subject. While I have seen no reason to change or alter any of the identifications, I believe it may assist in their general acceptance to lay before the Academy the further evidence in support of them which is contained in the following pages.

Although it is perhaps scarcely necessary to emphasize the importance of, nor to specify the advantage which is to be derived from, the application of a scientific method to the analysis of these old myths, still I cannot but refer to the remarks by the late Professor Rolleston, in which he condemns the sneers with which attempts to preserve the unities of time and place in faunas have been met in some quarters. And many naturalists will doubtless concur in his remark,

[1] These *Proceedings*, 2nd Ser., vol. ii., p. 513 (Pol. Lit. and Antiq.), and republished in the *Indian Antiquary*, *Bombay*.

that "it is rare, indeed, to find a writer of the classical period making blunders in the way of putting animals into places in which they never were found, except in connexion with the circus of olden, and the menagerie of modern times, which are so rife in all but our very best modern authors."

MAMMALS.

The Martikhora (Μαρτιχώρας, Ανδροφάγος).

Felis Tigris, Linn.—The Tiger.

The identification of the *martikhora* with the tiger, in the previous Paper, where it was pointed out that the scorpion-like characteristics could readily be explained by the presence of the sharp horny appendage on the extremity of the tail in the *Felidæ*, has led me to note, among other curious facts in that connexion, that the "old Assyrians (as pointed out by the Rev. Mr. Houghton[1]) seem to have noticed the horny process (on the tail of the lion) which is now and then figured, though with exaggeration, on the marble slabs." The same author states, however, that classical authors make no mention of it when speaking of the lion lashing himself with his tail when angry. The ingenious suggestion, that the natural function of the sharp point was to rouse the animal to fury is, therefore, probably of no great antiquity, and has, so far as I am aware, nothing else to commend it.

I may state that I recently took advantage of the delicate state of health of one of our lionesses in the Zoological Gardens to examine this structure, and found it to be hard and sharply pointed, but quite concealed from view by the hair at the extremity of the tail.

The Krokottas, or Kynolykos (Κροκόττας, Κυνόλυκος).

Hyæna crocuta.—The Spotted Hyena.

Ktesias states that the *krokottas*, which was identified as above in the previous Paper, occurs in Ethiopia. Now, although Ethiopia, it is believed, sometimes stood for India with the Greeks, it appeared in this case that if the identification was correct Ethiopia must here mean Africa, as the spotted hyena was not known to occur or to have occurred out of that geographical region. Quite recently, however, presumably pleistocene remains of the animal have been identified by Mr. R.

[1] *Natural History of the Ancients*, p. 107.

Lydekker[3] among the bones of various animals obtained in the caves at Billa Surgam, in Karnul in the Madras Presidency, where remains of the *Cynocephalus*, or dog-faced baboon of Africa, which is now extinct in India, were also obtained.

It is just conceivable that the spotted hyena may have survived in India into the prehistoric period; but the matter is rather of passing interest than importance, as there appears to be no necessity for demonstrating that, in this instance, Ktesias really meant India, as was supposed by Lassen, who identified the *krokottas*, I believe incorrectly, with the jackal.

THE GRYPHON, OR GRIFFIN (Γρυψ).

Canis domesticus, var. *Tibetanus*.—Tibetan Mastiff.

All the additional information which has been acquired confirms the supposition that the original idea of the griffin was suggested by the Tibetan mastiffs which guard the houses and diggings of the gold miners now, as they, in all probability, did in the time of Herodotus and Ktesias.

I am enabled to exhibit an illustration of the griffin in the *Ortus Sanitatis*,[4] as it was developed by the fancy of Ælian, and side by side with it a photograph of the Tibetan mastiff, which is now in the Zoological Gardens. Both, it will be observed, exhibit even still some points in common, especially as regards the massive limbs, and "claws like a lion's."

Among superadded myths in connexion with the griffins, we are told that some of the tribes of Northern Asia consider that the horns of the Tichorhine rhinoceros, which are there found in a semi-fossil condition, were the talons of gigantic birds, and that MM. Ermann and Middendorf suppose that their discovery may have originated the account of the griffins by Herodotus. This theory of its origin is now, perhaps, scarcely necessary.

Since the above was written, Mr. Howorth's work on the Mammoth and the Flood has come to hand. In it he devotes several pages to the stories about the horns of the Tichorhine rhinoceros, and argues that the myth of the griffin was founded on the discovery of its remains in Northern Asia; but I think it possible that the myth about the griffins may have been older than the theory as to the nature of the horns. Be that as it may, the description by Ktesias was, I maintain, founded on the dogs.

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[3] *Records, Geol. Survey of India*, vol. xix., 1886, p. 120.

[4] *De Herbis, Animalibus, &c., De Avibus*, cap. lvi.

REPTILES.

The Skolex (Σκώληξ).

Crocodilus biporcatus, vel Garialis gangeticus.—The Crocodile,[5] or the *Garial.* (The Gavial of authors.)

When I made the suggestion that as in other cases Ktesias had, with reference to crocodile oil, combined information about what were in reality two quite different subjects, I was unaware that the same explanation had already been made by a previous writer. In his valuable essay on "Early Asiatic Fire Weapons," General Maclagan, R.E., has pointed out[6] that to crocodile oil—a recognized Indian medicine—Ktesias had apparently attached the attributes which properly belong to the Punjab petroleum, thus explaining the inflammability of the oil and its use in warfare, as the material for fireballs for setting cities on fire. I do not doubt, therefore, that this explanation will find a ready acceptance, and I venture to hope that similar acceptance will be given to many of the other suggested identifications, when the evidence upon which they are based has been fairly weighed.

In the present communication I give another example of a combined story in the case of the *parebon* tree, having been enabled to trace the origin of the properties attributed to its juice to the well-known characteristics of a distinct plant.

INSECTS.

Honey (Μελι).

Apis dorsata.—Bee. *Bhaunra,* Hin.

When explaining Ktesias's mention of "a certain river flowing with honey out of a rock, like the one we have in our own country," by the fact that wild bees are found in the rocky gorges of some Indian rivers, and that their honey is much sought after by the natives, I omitted to mention that the same explanation would apply to the words of the Psalmist: "He should have fed them also with the finest of the wheat, and with *honey out of the stony rock* would I have satisfied thee."

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[5] It has been urged as an objection to this identification, that *Skolex,* literally translated, means 'worm.' To this I reply that the same zoological classification has sometimes also been applied to poor humanity.

[6] *Jour. Asiat. Society, Bengal,* xlv., pp. 50–51.

This explanation may have suggested itself independently to others, and certainly did so to Forbes,[7] who further remarks that the brooks of honey and butter mentioned by Zophar, in the book of Job, probably referred to liquid honey from wild bees and *ghi*, or clarified butter. The habits of the wild bees, it may be remarked, appear to be the same in Judea as they are in India.

ELEKTRON (Ἤλεκτρον).

Coccus lacca.—The Lac Insect and its Products, Shell-lac and Lac Dye.

The identification in the former Paper of the Indian *elektron* and the dye associated with it, as described by Ktesias, shows that there were really four substances to which the term was applied by classical authors, the other three hitherto only recognised being, as enumerated by Mallin[8]—1, glass; 2, a metallic alloy; and 3, amber.

When combating the vague suggestion that the red dye was produced from cochineal insects, I stated that the latter did not occur in India, whereas it would have been more correct to say, were not indigenous to India, since, as a matter of fact, both they and the cactus were introduced into the country many years ago;[9] and it is also known that they were introduced into Batavia.[10] Sir A. Burnes mentions cochineal (prepared) as being an import into India by way of Cabul.

The recently-published Anglo-Indian Glossary by Colonel Yule and Mr. Burnell contains a number of interesting and quaint extracts from early writers on the subject of Indian lac.[11]

THE DIKAIRON (Δίκαιρον).

Scarabæus sacer, Linn.—The Dung Beetle.

I am indebted to Professor Mir Aulad Ali for the statement that there is an Arabic word, *sikairon*, which may, perhaps, be connected with the above: it means 'concealer,' and might very aptly be applied to the beetle, which spends so much of its time in burying pellets of cattle-droppings in which its eggs are deposited.

In Houghton's Natural History of the Ancients there is some interesting information regarding the *scarabæus* of Egypt.

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[7] *Oriental Memoirs*, vol. i., p. 32.
[8] *Mineralogie Homerique*, p. 49.
[9] Pennant, *View of Hindostan*, vol. ii., p. 97.
[10] See *Biervillas' Voyage*, vol. ii., p. 128.
[11] Page 380.

PLANTS.

Honey from Canes called Sugar (Μέλι τὸ καλάμινον τὸ λεγόμενον σαχαρ).

Saccharum officinarum, Linn.

With reference to the suggestion made in the previous Paper, pp. 330, 335, that the "stones, described by Strabo as being dug up in India, which are of the colour of frankincense, and sweeter than figs or honey," were sugar-candy, it may be of interest to state, that Babar, in his "Memoirs,"[12] referring to a period about A.D. 1504, says that "the commodities imported into Cabul from Hindostan are slaves, white clothes, *sugar-candy*, refined and common sugar, drugs and spices."

The Indian Reed (Κάλαμος Ἰνδικός).

Borassus flabelliformis, Linn.—The Palmyra Palm.

When identifying the "Indian reed" of the Greeks and Romans with the Palmyra palm, instead of with the bamboo, as it has generally been by previous writers, I stated, in addition to the arguments upon which that opinion was formed, that the Sanskrit name for the palm was *trina-raja*, or "king of the reeds," from which the Greeks very possibly derived their idea as to the nature of the plant. But, as regards the possible size to which a bamboo may grow under favourable circumstances, some further remarks are now called for. Colonel Yule (Anglo-Indian Glossary) states that an effort to procure the largest obtainable bamboo in Pegu, in the year 1855, yielded one of only a little over 10 inches in diameter; and recently, in the Colonial Exhibition, the largest in the collection I found to be just 10 inches in its maximum diameter, being somewhat compressed in section.

However, Professor Hæckel, in his account of his visit to Ceylon,[13] speaks of bamboos in the Botanic Gardens 1 to 2 feet thick, the precise meaning of which is exemplified by the addition that a child of three could therefore stand inside one section of the main stem. There is, moreover, the authority of Clusius, quoted by Colonel Yule, that he had seen two great specimens in the University at Leyden, 30 feet long and from 14 to 16 inches in diameter.

Such monsters may occur under favourable circumstances in Ceylon, just as Hæckel also describes Arabian palms, which in Ceylon

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[12] Erskine, p. 138, and Sir A. Burne's *Cabool*, pp. 79 and 84.

[13] *A Visit to Ceylon*, translated by Clara Bell, p. 136.

have grown to sizes unknown in their native country; but as regards India, I have in vain sought for evidence of the largest species of bamboo ever exceeding 10 inches in diameter. It is *Bambusa arundinacea*, but the *Dendrocalamus giganteus* of Penang is said to attain to 12 inches. (See Note added in the Press, p. 9.)

Acosta is sometimes supposed to be responsible for renewing a form of the story as it was first told by Herodotus. Paludanus, in his annotation to Linschoten,[14] quotes him as follows:—"Of the tree or reede called bambus, some of the Indians make *scutes*, or little skiffes, wherein (should be whereon) two men may sitte, which they doe not altogether make hollow within, but leave two knots of partitions uncarved. In (should be on) these *scutes* the Indians sit naked, at ech end one, crosse-legged, and in ech hand an oare wherewith they rule the boate, and drive her swiftly against the streame, specially in the river called Cranganor; and they are of this opinion that those *scutes* are never overturned by the crocodiles, although they come about them, as others are—but for these it was never heard of."

A correct version of Acosta's original passage in "Tractado," p. 296 (1578), will be found in the Anglo-Indian Glossary, by Colonel Yule and Mr. Burnell.

The following, which is probably derived from the same source, namely, Acosta, and should not, perhaps, be regarded as an original observation, occurs in Mandelslo's travels:[15]—"These canes are so big that the Indians cleave them to make boats, leaving a knot at each end, *whereon!* they sit to guide it—one before, another behind—and use this sort of boat the rather, for that they are persuaded crocodiles bear a respect to the *mambu* (i. e. bamboo) and never hurt the boats made of this cane."

It seems to be probable that this comparatively modern (16th century) version of the story arose from bamboos being used as buoyant cylinders, and for this purpose the partitions at the nodes would not be removed. It appears to have been the custom for two natives to seat themselves astride on such cylinders, at either end, and some of the translators of Acosta seem to have given a complexion to the statements made by him which was not intended. A translator or annotator striving to make his author intelligible might naturally fall into such a mistake with the best possible intentions.

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[14] *Voyage of Linschoten, Hakluyt Soc.*, vol. ii., p. 68. See also Pennant's *View of Hindostan*, vol. i., p. 143.

[15] Lib. ii., p. 120.

As the men's legs dangled in the water, just as do those of men who cross rivers on inflated skins or *mussacks*, the reference to crocodiles becomes intelligible; and it is possible that the cylinder of bamboo might have some deterrent influence upon them, as it might seem to be a trap.

Of course the connexion with the story by Herodotus is not really very close, as his, I think, certainly referred to boats made of the palm.

The Parebon Tree (Πάρηβον).

Ficus religiosa, Linn.—*Pipal*, Hin. *Bo*, Sansk.

In my identification of this tree, I omitted to point out that the *Ficus religiosa* is the *bo* tree of the early Buddhists. It was therefore one which would naturally have been brought under the special notice of the Greeks. Moreover, it seems probable that in the name *parebon* we have incorporated the Sanskrit name *bo;* and this seems a more probable derivation than that it is from *pipul*, or *pipun*, as it is sometimes pronounced.

The famous *bo* tree of Ceylon, described by Sir Emerson Tennent[16] and many others, was planted in 288 B.C., and is undoubtedly the oldest existing vegetable with a recorded history.

The ascription to the juice of the *parebon* tree, by Ktesias, of the property of thickening water or wine when dropped into them, was, possibly, an error; but there is a plant in Ceylon which possesses the property in a remarkable degree. It is the *bakatoo*, or *Pedalium murex* (Nat. Ord. Pedaliaceæ), of which Sir Emerson Tennent[17] has written as follows:—"If bits of the stem, leaves, and roots, be mixed for a few seconds in milk or water, the liquid turns thick and mucilaginous; so much so, that water in this state can be raised by the hand several feet out of a basin, and let fall back without noise; and this without imparting any colour, taste, or smell to the fluid, which returns to its natural state in about ten or fifteen minutes afterwards. The Singhalese take advantage of this peculiarity of the *bakatoo* to thicken the milk sent round to Europeans."

[Note added in the Press.

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[16] *Ceylon*, vol. ii., p. 613. [17] *Op. cit.*, p. 160.

NOTE ADDED IN THE PRESS.

Dr. E. P. Wright, in the discussion that followed the reading of this Paper, mentioned that at Mahé in the Seychelles, the *D. giganteus* grew under very favourable circumstances, but that he had never known the stems to exceed 10 or 11 inches in diameter; and while this Paper has been awaiting publication I have availed of the opportunity of transmitting an inquiry on the subject, through Mr. F. W. Moore, to Dr. Trimen, Director of the Botanic Gardens at Peradeniya, who has replied, that the diameter of the culms of *Dendocalamus giganteus* (or, possibly, *D. Brandisii*), which is the largest species in the Gardens, does not exceed 9½ inches He adds, that there is a very large species in Japan, which may reach a larger size.

Having communicated this fact to Professor Hæckel, he has replied as follows:—"I cannot doubt that the statements of Dr. Trimen, regarding the size of the *Bambusa* at the Peradeniya Gardens are perfectly correct, and that my own estimations (in the Ceylon letter) are too high, due to my mistaken note." Hence, I think, it may now be fairly concluded that definite evidence of the diameter of the stems of any species of bamboo in India or Ceylon, exceeding about 10 inches, does not exist.

II.

ON A NEW METHOD OF OBTAINING THE CONDITIONS FULFILLED WHEN THE HARMONIC DETERMINANT EQUATION HAS EQUAL ROOTS. By FRANCIS A. TARLETON, LL.D., F.T.C.D.

[Read November 14, 1887.]

The harmonic determinant possesses a peculiar interest, both on account of the importance of the physical problems with which it is connected, and also because it is associated with the names of some pre-eminently great mathematicians.

Lagrange, in the Mécanique Analytique, shows that the small oscillations of a system whose position is determined by n independent variables depend on the solution of an equation of the n^{th} degree. This equation in its most general shape is of the form

$$\begin{vmatrix} p_{11}-\lambda f_{11} & p_{12}-\lambda f_{12}\ldots p_{1n}-\lambda f_{1n} \\ p_{12}-\lambda f_{12} & p_{22}-\lambda f_{22}\ldots p_{2n}-\lambda f_{2n} \\ \vdots & \\ p_{1n}-\lambda f_{1n} & \ldots\ldots\ldots\ldots p_{nn}-\lambda f_{nn} \end{vmatrix} = 0.$$

The determinant which enters into this equation is called the harmonic determinant, as each root of the equation corresponds to an oscillation which all the variables of the system complete in the same time.

Lagrange appears to have been but slightly acquainted with the properties of this determinant, and, as is now well known to mathematicians, was mistaken in reference to the consequences which result when the equation above has equal roots. Laplace fell into the same mistake as Lagrange, and Dr. Routh of Cambridge has the honour of being the first to point out the error of the great French mathematicians.

It would, however, have been scarcely possible for this error to have remained much longer undetected. Looked at from the physical

standpoint, Lagrange's solution in the case of equal roots was readily seen to be incorrect, by taking the extremely simple case of a particle disturbed from the lowest point of the internal surface of a smooth sphere; whilst on the purely mathematical side the increasing knowledge of Higher Algebra soon led to a complete acquaintance with the properties of the harmonic determinant.

It is strange that, nevertheless, no simple investigation of the conditions fulfilled when two or more roots of the equation in λ become equal has been given, so far as I know.

The subject is discussed in Salmon's Higher Algebra, as well as in Thomson and Tait's Natural Philosophy; but in each of these works, especially the latter, it presents considerable difficulty to the student. Burnside and Panton on this matter have not, I believe, added anything to what is to be found in Salmon's Higher Algebra. In Williamson and Tarleton's Dynamics, a mode of investigation obscurely indicated by Thomson and Tait is fully developed; but this method, though not very difficult, is highly artificial in its character, and was adopted in the Dynamics, merely on account of the length and difficulty of the other known methods of investigation.

A special case of the more general problem occurs in finding the conditions fulfilled by the general equation of the second degree when it represents a surface of revolution. The mode in which this question is treated in Salmon's great work throws but little light on the general problem. A less special mode of investigation can easily be given as follows:—

The equation of a surface of the second degree, referred to its axes, is of the form

$$A\xi^2 + B\eta^2 + C\zeta^2 = K.$$

Before transformation, the origin being the centre, it was of the form

$$U = K.$$

If we put $V = \xi^2 + \eta^2 + \zeta^2$, the discriminant, Δ, of $U - \lambda V$ is

$$(A - \lambda)(B - \lambda)(C - \lambda).$$

If the surface be one of revolution, $A = B$, and the equation $\Delta = 0$ has equal roots, the value of the double root being A.

In this case $U - AV = (C - A)\zeta^2$, and therefore $U - AV$ is a

function of the single variable ζ. Hence, when the single equation $\zeta = 0$ is fulfilled, we must have

$$\frac{dU}{dx} - A\frac{dV}{dx} = 0, \quad \frac{dU}{dy} - A\frac{dV}{dy} = 0, \quad \frac{dU}{dz} - A\frac{dV}{dz} = 0.$$

Hence, again, if A be a double root of the equation $\Delta = 0$, these three equations can be satisfied by one of the variables, the other two remaining arbitrary. If the general expression for U be

$$ax^2 + by^2 + cz^2 + 2lyz + 2mzx + 2nxy,$$

we have, then, the system of equations obtained by equating to zero every single first minor of the determinant Δ, or

$$\begin{vmatrix} a-\lambda & n & m \\ n & b-\lambda & l \\ m & l & c-\lambda \end{vmatrix},$$

where λ is a double root of the equation $\Delta = 0$.

At first sight it would seem that this method of investigation might be extended; but if we assumed in general, as is assumed in the particular case above, that two quantics of the second degree could always be transformed, one into a sum of squares of the variables, the other into a sum of squares of the same variables multiplied by constant coefficients, we could show, in the same manner as above, that any two conics which touch must have double contact. For, if they touch, the equation got by equating to zero the discriminant of $U - \lambda V$ ($U = 0$, and $V = 0$, being the equations of the conics) must have equal roots, in which case, as shown above, if A be the value of the double root, $U - AV$ must be the square of a linear function of the variables; whence the conics must have double contact at the two extremities of the line represented by equating this linear function to zero. The absurdity of this result shows that we have no right to assume without proof the possibility of the transformation in question.

Enough has been said to lead us to conclude that the problem before us possesses a considerable amount both of interest and difficulty.

The harmonic determinant in its most general form is obviously the discriminant of $U - \lambda V$, where U and V are each quantics of the second degree in n variables.

In the present case, moreover, when we substitute in V for the

variables their differential coefficients with respect to the time, we obtain an expression for the *vis viva* of the system. Hence V is always positive, and may therefore, by linear transformation, be expressed as the sum of the squares of the n variables.

If U be transformed into a function of these same variables, the harmonic determinant becomes

$$\begin{vmatrix} p_{11}-\lambda & p_{12} & p_{13} \cdots\cdots p_{1n} \\ p_{12} & p_{22}-\lambda & p_{23} \cdots\cdots p_{2n} \\ \vdots & & \\ p_{1n} & p_{2n} & p_{3n} \cdots\cdots p_{nn}-\lambda \end{vmatrix}.$$

This determinant we shall call Δ.

If we erase the first row and first column of Δ, we get a new determinant which may be called Δ_{11}. In like manner, Δ_{22} may be used to signify the determinant got by erasing the second row and second column of Δ, and Δ_{12} that obtained by erasing the first row and second column, and so on.

Let us now consider the determinant

$$\begin{vmatrix} p_{11}-\Lambda_1 & p_{12} & p_{13} \cdots p_{1n} \\ p_{12} & p_{22}-\Lambda_2 & p_{23} \cdots p_{2n} \\ \vdots & & \\ p_{1n} & p_{2n} & p_{3n} \cdots p_{nn}-\Lambda_n \end{vmatrix},$$

which we may call Δ', in which Λ_1, Λ_2, &c., are functions of λ.

We have, then,

$$\frac{d\Delta'}{d\lambda} = \frac{d\Delta'}{d\Lambda_1}\frac{d\Lambda_1}{d\lambda} + \frac{d\Delta'}{d\Lambda_2}\frac{d\Lambda_2}{d\lambda} + \&c.$$

If we now suppose

$$\Lambda_1 = \Lambda_2 = \Lambda_3 = \&c. = \lambda,$$

the equation above becomes

$$\frac{d\Delta}{d\lambda} = -(\Delta_{11} + \Delta_{22} + \&c. + \Delta_{nn}). \qquad (1)$$

Hence, if λ be a double root of the equation $\Delta = 0$, we must have, for this value of λ,

$$\Delta_{11} + \Delta_{22} + \&c. + \Delta_{nn} = 0. \qquad (2)$$

We shall now show that if λ be a root of the equation $\Delta = 0$, the determinants Δ_{11} and Δ_{22} must have the same algebraical sign.

This readily appears by considering the system of n linear equations—

$$
\begin{aligned}
(p_{11} - \lambda)x_1 + p_{12}x_2 + p_{13}x_3 + \&c. + p_{1n}x_n &= 0,\\
p_{12}x_1 + (p_{22} - \lambda)x_2 + p_{23}x_3 + \&c. + p_{2n}x_n &= 0,\\
\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot&\\
\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot&\\
p_{1n}x_1 + p_{2n}x_2 + p_{3n}x_3 + \&c. + (p_{nn} - \lambda)x_n &= 0.
\end{aligned}
$$

If λ be a root of the equation $\Delta = 0$, any $(n-1)$ of these equations enables us to determine the $n-1$ ratios between the quantities x_1, x_2, &c.; and whatever equation we leave out, the results must be consistent.

If we omit the first equation, and from the remaining ones solve for x_2 in terms of x_1, we get

$$\Delta_{11}x_2 = - \Delta_{12}x_1.$$

In like manner, if we omit the second equation, and solve for x_1 in terms of x_2, we obtain

$$\Delta_{22}x_1 = - \Delta_{21}x_2.$$

But from the symmetry of Δ, it is plain that $\Delta_{12} = \Delta_{21}$; whence we have

$$\Delta_{11}\Delta_{22} = \Delta^2_{12}. \qquad (3)$$

Hence, if λ be a root of the equation $\Delta = 0$, the determinants Δ_{11} and Δ_{22} must have the same algebraical sign. As this is true of any two of the set of determinants in each one of which the two suffixes are the same, it follows that they must all in this case have the same sign; and, therefore, if their sum be zero, each one of them must be zero. When each one of the determinants Δ_{11}, Δ_{22}, &c., vanishes, equation (3) shows that all the other first minors of Δ must likewise vanish.

Hence, when λ is a double root of the equation $\Delta = 0$, every first minor of Δ must vanish.

It is easy to extend this investigation to cases in which three or more roots are equal.

In fact, if λ be a triple root of the equation $\Delta = 0$, it is a double root of the equation $\Delta_{11} = 0$, and therefore all the first minors of Δ_{11} must vanish, as well as all the first minors of Δ.

In general, if the equation $\Delta = 0$ have m roots equal to λ, all the first minors of Δ, of Δ_{11}, of $\Delta_{11\,22}$, and so on up to and including $\Delta_{11\,22\,\ldots\,(m-2)(m-2)}$, must vanish.

It is well to observe that equation (3) follows immediately from a more general theorem given in Salmon's Higher Algebra, and which, for any determinant, is expressed, according to our notation, in the form

$$\Delta_{11}\Delta_{22} - \Delta_{12}\Delta_{21} = \Delta\Delta_{11\,22}. \tag{4}$$

When the determinant Δ is symmetrical, and likewise zero, this equation becomes the same as (3).

Mr. Williamson has recently pointed out that, from equation (4), it follows that in the case of the harmonic determinant, when Δ_{11} vanishes, Δ and $\Delta_{11\,22}$ take opposite signs. Hence can be obtained an easy and beautiful proof of the reality of the roots of the equation $\Delta = 0$. This proof is to be found in Salmon's Higher Algebra, but is there rendered somewhat difficult by the generality of the investigations with which a part of it is intermixed.

III.

ON THE DETERMINATION OF THE NUMERICAL FACTORS IN THE EXPANSION OF LAPLACE'S COEFFICIENTS. BY FRANCIS A. TARLETON, LL.D., F.T.C.D.

[Read NOVEMBER 30, 1887.]

IF the expression
$$(1 - 2\lambda h + h^2)^{-\frac{1}{2}},$$
where
$$\lambda = \mu\mu' + \sqrt{1-\mu^2}\sqrt{1-\mu'^2}\cos(\phi - \phi'),$$
be expanded in a series of ascending powers of h, the quantities by which the powers of h are multiplied are termed Laplace's coefficients, and are usually indicated by the symbols L_1, L_2, &c., L_i.

If μ be substituted for λ in the expression given above, the multipliers of the powers of h in the corresponding expansion are called Legendre's coefficients, and may be indicated by the symbols P_1, P_2, &c., P_i.

It is proved in Williamson's Differential Calculus that
$$L_i = \Sigma_0^i a_n u^{\frac{n}{2}} u'^{\frac{n}{2}} D^n P_i D'^n P_i' \cos n(\phi - \phi'),$$
where
$$u = \mu^2 - 1, \quad u' = \mu'^2 - 1,$$
$$D = \frac{d}{d\mu}, \qquad D' = \frac{d}{d\mu'},$$
P_i' is the same function of μ' which P_i is of μ, and a_n is a function of i and n, independent of μ, μ', ϕ, and ϕ'.

The value of a_n has been usually arrived at by means of a laborious trigonometrical expansion. The object of the present investigation is to show that it can readily be obtained by the use of the fundamental theorems of the Laplacian analysis.

By using the well-known theorem
$$\int_{-1}^{+1}\int_0^{2\pi} Y_i L_i \, d\mu d\phi = \frac{4\pi}{2i+1} Y'_i,$$

where Y_i is a spherical harmonic of the degree i, and comparing co-efficients of $\cos n\phi'$, it is easy to show, as in Laplace, Mécanique Céleste, book iii., section 17, that

$$a_n\int_{-1}^{+1}(\mu^2-1)^n(D^nP_i)^2d\mu=\frac{4}{2i+1}, \tag{1}$$

except $n=0$, in which case

$$a_0\int_{-1}^{+1}P_i^2d\mu=\frac{2}{2i+1}. \tag{2}$$

If we put
$$\int_{-1}^{+1}u^n(D^nP_i)^2d\mu=\Lambda_n,$$

we have, then,
$$a_n\Lambda_n=\frac{4}{2i+1},$$

except $n=0$, in which case

$$a_0\Lambda_0=\frac{2}{2i+1}.$$

We shall now prove that

$$\Lambda_{n+1}+(i-n)(i+n+1)\Lambda_n=0. \tag{3}$$

This readily follows, from the differential equation satisfied by P_i, viz.:—

$$D(uDP_i)-i(i+1)P_i=0.$$

If we operate on this equation with D^n, we obtain

$$D^{n+1}(uDP_i)-i(i+1)D^nP_i=0.$$

Expanding the first term by Leibnitz' theorem, and remembering that

$$D^2u=2,\quad D^3u=0,$$

we get

$$uD^{n+2}P_i+(n+1)DuD^{n+1}P_i+\{n(n+1)-i(i+1)\}D^nP_i=0,$$

or

$$uD^{n+2}P_i+(n+1)DuD^{n+1}P_i=(i-n)(i+n+1)D^nP_i. \tag{4}$$

From the definition of Λ_n we have

$$\Lambda_{n+1}+(i-n)(i+n+1)\Lambda_n$$

$$=\int_{-1}^{+1}\{u^{n+1}(D^{n+1}P_i)^2+(i-n)(i+n+1)u^n(D^nP_i)^2\}\,d\mu.$$

If in the right-hand member of this equation we substitute for

$$(i-n)(i+n+1)D^n P_i$$

its value from equation (4), we obtain

$$\Lambda_{n+1} + (i-n)(i+n+1)\Lambda_n$$

$$= \int_{-1}^{+1} \{(n+1)u^n Du D^n P_i D^{n+1} P_i + u^{n+1} D^n P_i D^{n+2} P_i + u^{n+1} (D^{n+1} P_i)^2\} \, d\mu$$

$$= \int_{-1}^{+1} D\{u^{n+1} D^n P_i D^{n+1} P_i\} \, d\mu = 0,$$

since u vanishes for $\mu = 1$, and also for $\mu = -1$.

By making $\mu = \mu' = 1$, L_i is reduced to unity; but, on the hypothesis above, $P_i = P_i' = 1$. Hence we see that $a_0 = 1$.

We have now, from equation (2),

$$\Lambda_0 = \frac{2}{2i+1}.$$

Hence, from (3), we obtain

$$\Lambda_1 = -i(i+1)\frac{2}{2i+1},$$

$$\Lambda_2 = (i-1)i(i+1)(i+2)\frac{2}{2i+1}, \text{ \&c.,}$$

and in general

$$\Lambda_n = (-1)^n \frac{2}{2i+1}(i+n)(i+n-1)\ldots(i-n+1).$$

Substituting this value of Λ_n in equation (1), we get finally

$$a_n = \frac{2(-1)^n}{(i+n)(i+n-1)\ldots(i-n+1)} = 2(-1)^n \frac{\lfloor i-n}{\lfloor i+n}. \quad (5)$$

The value of a_n, as given by equation (5), does not seem to agree with the value which Laplace obtains for the numerical factor which he terms γ. It is easy to show that this disagreement is only apparent.

In the expansion of his coefficient, L_i, Laplace takes unity as the coefficient of the highest power of μ in the function of μ multiplying

$$\cos n(\phi - \phi'),$$

and puts $1-\mu^2$, instead of μ^2-1 or u. In our mode of writing L_i, which is that adopted by Williamson, Differential Calculus, $\cos n(\phi-\phi')$ is multiplied by a function of μ, which is expressed by $D^n P_i$, or

$$\frac{1}{2^i \lfloor i} D^{i+n}(\mu^2-1)^i.$$

The coefficient of the highest power of μ in this is plainly

$$\frac{2i(2i-1)(2i-2)\ldots(i-n+1)}{2^i \lfloor i},$$

which may be written

$$\frac{\lfloor 2i}{2i(2i-2)\ldots 2 \,.\, \lfloor i-n},$$

and this last is manifestly

$$\frac{(2i-1)(2i-3)\ldots 3\,.\,1}{\lfloor i-n}.$$

Hence we see that

$$\left\{\frac{1\,.\,3\,.\,5\ldots(2i-1)}{\lfloor i-n}\right\}^2 a_n = (-1)^n \gamma;$$

whence

$$\gamma = 2\left\{\frac{1\,.\,3\ldots(2i-1)}{\lfloor i-n}\right\}^2 \frac{\lfloor i-n}{\lfloor i+n} = \frac{2\{1\,.\,3\ldots(2i-1)\}^2}{\lfloor i-n\,.\,\lfloor i+n}.$$

This last expression for γ is at once reducible to that given by Laplace, viz.:—

$$2\left\{\frac{1\,.\,3\,.\,5\ldots(2i-1)}{\lfloor i}\right\}^2 . \frac{i(i-1)\ldots(i-n+1)}{(i+1)(i+2)\ldots(i+n)}.$$

IV.

NOTE ON THE APPLICATION OF SYMBOLICAL METHODS TO THE SOLUTION OF CERTAIN FUNCTIONAL EQUATIONS. By M. W. CROFTON.

[Read April 25, 1888].

1. Take the functional equation

$$\phi(x+h) = a\phi(x),$$

where h, a are given constants. Let $\phi(x) = y$;

$$\therefore \quad e^{hD}y = ay.$$

If we operate on both sides by e^{hD},

$$e^{2hD}y = e^{hD}ay = a^2y.$$

In like manner, $e^{rhD} = a^r y$;

and therefore $f(e^{hD})y = f(a)y \ldots (a)$,

if f be any rational and integral function. Assuming it to hold for all functions; *e.g.* for $f(x) = \log x$,

$$hDy = \log a \,.\, y;$$

$$\therefore \quad y = Ce^{\frac{\log a}{h}x};$$

$$\therefore \quad \phi(x) = Ca^{\frac{x}{h}}.$$

It is not pretended that this process gives the unique or complete solution: as if $f(a)$ is irrational or logarithmic, &c., and therefore admits of several values, (a) is really equivalent to several equations.

In fact, in the present example, suppose $h = 3$, and putting the question as one in finite differences,

$$u_{x+3} = au_x,$$

of which the complete solution is

$$u_x = (C_1 + C_2\omega^x + C_3\omega^{2x})a^{\frac{x}{3}}:$$

where, moreover, the *constants* C_1, C_2, C_3 may be of such forms as

$$C_1 \tan \frac{\pi x}{3}, \text{ \&c.}$$

2. To find a solution of

$$\phi(mx) = a\phi(x);$$

$$\therefore \quad m^{xD} y = ay;$$

hence, as before,

$$\log m \,.\, xDy = \log a \,.\, y;$$

$$\therefore \quad \phi(x) = Cx^{\frac{\log a}{\log m}}. \;*$$

3. If

$$\phi(mx) = a\phi(x) + bx^r,$$

$$m^{xD} y - ay = bx_r;$$

$$\therefore \quad y = b(m^{xD} - a)^{-1} x^r = \frac{bx^r}{m^r - a} + Cx^{\frac{\log a}{\log m}}.$$

4. Let us take Laplace's equation—

$$\phi(mx + n) = a\phi(x).$$

We may express this as

$$\phi(my + c) = a\phi(y + c),$$

where

$$y = x - c, \quad c = \frac{n}{1 - m}.$$

Now, let

$$\psi(y) = \phi(y + c),$$

and by (2), above, as

$$\psi(my) = a\psi(y),$$

$$\psi(y) = Cy^{\frac{\log a}{\log m}};$$

$$\therefore \quad \phi(y + c) = \phi(x) = C\left(x - \frac{n}{1 - m}\right)^{\frac{\log a}{\log m}}.$$

In the Proceedings of the London Mathematical Society, vol. xii., I have shown that if z, x are related by the condition

$$\psi(z) = 1 + \psi(x),$$

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* This might have been found from (1); as if we put

$$\psi(\log x) = \phi(x),$$

$$\phi(mx) = \psi(\log x + \log m) = a\psi(\log x);$$

$$\therefore \quad \psi(\log x) = Ca^{\frac{\log x}{\log m}} = Cx^{\frac{\log a}{\log m}}.$$

where ψ is a given function; then whatever be the function F,

$$\epsilon^{\phi D} F(x) = F(z),$$

where, for shortness, $\qquad \phi = \phi(x) = \dfrac{1}{\psi'(x)}.$

Thus, for instance, let

$$\psi(x) = -\frac{1}{x}; \quad \therefore \ \phi(x) = x^2.$$

And since $\qquad -\dfrac{1}{z} = 1 - \dfrac{1}{x}, \quad \therefore \ z = \dfrac{x}{1-x}.$

Hence $\qquad \epsilon^{x^2 D} F(x) = F\left(\dfrac{x}{1-x}\right),$

also $\qquad \epsilon^{hx^2 D} F(x) = F\left(\dfrac{x}{1-hx}\right).$

5. Thus, if we are given the functional equation

$$\phi\left(\frac{x}{1+hx}\right) = a\phi(x),$$

if $\qquad \phi(x) = y, \quad \epsilon^{-hx^2 D} y = ay,$

as before, $\qquad - hx^2 Dy = \log ay;$

$$\therefore \quad \phi(x) = Ca^{\frac{1}{hx}}.$$

6. In the same Paper it is shown that

$$r^{x \log x D} F(x) = F(x^r).$$

Hence the functional equation

$$\phi(x^r) = a\phi(x)$$

is equivalent to

$$\log r \,.\, x \log x \,.\, Dy = \log a \,.\, y;$$

$$\therefore \quad \log y = \frac{\log a}{\log r}\int \frac{dx}{x \log x} = \log a \,.\, \frac{\log \log x}{\log r} + C;$$

$$\therefore \qquad \phi(x) = C exp \,.\left(\log a \,\frac{\log \log x}{\log r}\right),$$

or $\qquad \phi(x) = C(\log x)^{\frac{\log a}{\log r}}.$

This example, by putting $\phi(x) = \psi(\log x)$, would have given

$$\psi(r \log x) = a\psi(\log x),$$

and thus be reduced to (2), above.

7. To determine a function ϕ, such that

$$\phi(x+D)e^{ax} = me^{ax}\phi(x).$$

It is known that

$$\phi(x+D) = e^{\frac{1}{2}D^2}\phi(x)e^{-\frac{1}{2}D^2} \ldots \quad (\beta).$$

Hence
$$\phi(x+D)e^{ax} = e^{\frac{1}{2}D^2}e^{ax}\phi(x)\,.\,e^{-\frac{1}{2}a^2};$$

$$\therefore \quad \phi(x+D)e^{ax} = e^{-\frac{1}{2}a^2}e^{ax}e^{\frac{1}{2}(D+a)^2}\phi(x)$$

$$= e^{ax}.\,e^{\frac{1}{2}D^2+aD}\phi(x).$$

Hence
$$me^{ax}\phi(x) = e^{ax}e^{\frac{1}{2}D^2+aD}\phi(x).$$

Put $y = \phi(x)$, and we have, as above,

$$(\tfrac{1}{2}D^2 + aD)y = \log m\,.\,y;$$

$$\therefore \quad \frac{d^2y}{dx^2} + 2a\frac{dy}{dx} - \log.m^2.y = 0;$$

$$\therefore \quad y = Ce^{Ax} + C_1e^{Bx},$$

where A, B stand for $-a \pm \sqrt{a^2 + \log.m^2}$.

It is easy to verify the correctness of the result by means of the theorem

$$e^{A(x+D)}.\,F(x) = e^{\frac{1}{2}A^2}e^{Ax}F(x+A),$$

which easily follows from (β), above.

I have thought it worth while presenting these few examples to the Academy, not as being themselves of much importance, but as illustrating the use of symbolic operators in such equations. Very little is known as to the management of these symbols; but there is no doubt that any progress in this direction will assist in the theory of functional equations, which, as may be seen from the above cases, may often be at once converted into relations between symbols involving one or more variables with the signs of differentiation.

V.

ON THE DOUBLE STAR, STRUVE, 2120. By J. E. GORE, F. R. A. S., Honorary Associate and Vice-President of the Liverpool Astronomical Society.

[Read November 30, 1887.]

Assuming that the apparent change of position in the components of this double star is due to uniform rectilinear motion, I have computed the following formulæ:—

$$\rho^2 = 4{\cdot}9729 + 0{\cdot}0225\,(t - 1850{\cdot}4)^2,$$
$$\sec(317^\circ{\cdot}20 - \theta) = 0{\cdot}4484\,\rho.$$

The following is a comparison between the measures and the positions computed from the above formulæ. The observed angles have been corrected for the effect of precession to 1880·0:—

Epoch.	Observer.	θ_0.	θ_c.	$\theta_0 - \theta_c$.	ρ_0.	ρ_c.	$\rho_0 - \rho_c$.
		°	°	°	″	″	″
1783·20	Sir W. Herschel,	41·62	34·72	(+ 6·93)	11·88	10·32	+ 1·56
1829·60	Struve,	11·10	11·59	− 0·49	3·83	3·83	0·0
1832·52	,,	7·92	7·45	+ 0·47	3·54	3·49	+ 0·05
1833·47	,,	2·22	5·92	− 3·70	3·45	3·38	+ 0·07
1834·67	,,	4·63	4·05	+ 0·58	3·25	3·26	− 0·01
1835·38	,,	358·13	2·48	− 4·35	3·18	3·17	+ 0·01
1835·65	,,	1·63	1·95	− 0·32	3·20	3·14	+ 0·06
1836·55	,,	359·84	360·15	− 0·31	3·10	3·05	+ 0·05
1841·12	O. Struve,	345·57	349·21	− 3·64	2·83	2·63	+ 0·20
1841·44	Mädler,	346·77	348·25	− 1·48	2·8	2·60	+ 0·20
1842·49	,,	345·68	345·15	+ 0·53	2·76	2·52	+ 0·24
1842·55	Kaiser,	—	—	—	2·56	2·52	+ 0·04

EPOCH.	OBSERVER.	θ_o.	θ_c.	$\theta_o - \theta_c$.	ρ_o.	ρ_c.	$\rho_o - \rho_c$.
		°	°	°	″	″	″
1842·93	Kaiser.	341·58	343·61	− 2·03	—	—	—
1843·57	Mädler,	341·98	341·65	+ 0·33	2·62	2·45	+ 0·17
1844·38	,,	339·19	339·18	+ 0·01	2·52	2·40	+ 0·12
1845·42	,,	335·79	335·57	+ 0·22	2·52	2·35	+ 0·17
1847·15	,,	328·70	329·18	− 0·48	2·46	2·28	+ 0·18
1847·57	O. Struve,	324·40	327·95	− 3·55	2·19	2·27	− 0·08
1850·00	,,	314·32	317·20	− 2·88	2·25	2·23	+ 0·02
1851·09	Mädler,	314·83	314·63	+ 0·20	2·37	2·23	+ 0·14
1851·97	O. Struve,	306·63	311·30	(− 4·67)	2·19	2·24	− 0·05
1853·00	Mädler,	308·14	307·42	+ 0·72	2·35	2·26	+ 0·09
1855·10	,,	296·35	299·58	− 3·23	2·29	2·34	− 0·05
1855·51	Dembowski,	297·65	298·25	− 0·60	2·85	2·36	+ 0·49
1855·62	Morton,	297·95	298·89	+ 0·06	2·58	2·36	+ 0·22
1856·34	Dembowski,	293·86	295·50	− 1·64	2·6	2·40	+ 0·20
1856·76	Secchi,	290·26	294·07	− 3·81	2·49	2·42	+ 0·07
1857·12	O. Struve,	290·56	292·90	− 2·34	2·49	2·45	+ 0·04
1858·28	Mädler,	287·97	289·45	− 1·48	2·37	2·52	− 0·15
1858·47	Dembowski,	289·07	288·72	+ 0·35	2·5	2·54	− 0·04
1860·97	Mädler,	283·79	281·80	+ 1·99	2·88	2·74	+ 0·14
1861·63	O. Struve,	281·39	280·00	+ 1·39	2·97	2·80	+ 0·17
1862·51	Dembowski,	278·30	278·05	+ 0·25	3·03	2·88	+ 0·15
1863·39	,,	275·80	276·09	− 0·29	2·99	2·96	+ 0·03
1864·48	—	273·90	273·79	+ 0·11	2·87	3·07	− 0·20
1865·36	Engelmann,	268·60	272·03	− 3·43	3·41	3·16	+ 0·25
1865·40	Secchi,	272·80	272·04	+ 0·76	3·56	3·18	+ 0·38
1865·49	Dembowski,	272·02	271·78	+ 0·24	3·05	3·18	− 0·13

Epoch.	Observer.	θ_0.	θ_c.	$\theta_0 - \theta_c$.	ρ_0.	ρ_c.	$\rho_0 - \rho_c$.
		°	°	°	″	″	″
1865·51	Romberg,	270·52	271·72	– 1·20	—	—	—
1865·59	Secchi,	269·72	271·49	– 1·77	3·60	3·18	(+ 0·42)
1866·41	Talmage,	272·82	270·03	+ 2·79	3·56	3·28	+ 0·28
1867·16	Dembowski,	269·12	268·78	+ 0·34	3·26	3·36	– 0·10
1867·70	O. Struve,	269·12	267·90	+ 1·22	3·48	3·42	+ 0·06
1868·41	Talmage,	272·97	266·79	(+ 6·18)	3·58	3·51	+ 0·07
1868·45	Dembowski,	265·63	266·73	– 1·10	3·45	3·51	– 0·06
1869·55	,,	265·63	265·02	+ 0·61	3·51	3·63	– 0·12
1870·38	Main,	261·14	263·87	– 2·73	4·05	3·73	+ 0·32
1870·41	,,	258·84	263·83	(– 4·99)	3·80	3·73	+ 0·07
1870·45	Dembowski,	263·94	263·78	+ 0·16	3·79	3·74	+ 0·05
1870·60	Gledhill,	263·94	263·58	+ 0·36	3·8	3·76	+ 0·04
1871·14	Dunér,	264·95	262·85	+ 2·10	3·64	3·83	– 0·19
1871·21	Gledhill,	263·15	262·76	+ 0·39	3·6	3·84	– 0·24
1871·44	Dembowski,	262·45	262·45	0·0	3·75	3·86	– 0·11
1871·50	Gledhill,	263·35	262·38	+ 0·97	3·8	3·87	– 0·07
1871·51	Knott,	263·25	262·37	+ 0·88	3·86	3·87	– 0·01
1871·51	Talmage,	270·35	262·37	(+ 7·98)	2·97	3·87	(– 0·90)
1872·42	Dembowski,	261·15	261·25	– 0·10	3·96	3·98	– 0·02
1872·48	Wilson & Seabroke,	262·85	261·18	+ 1·67	3·78	3·99	– 0·21
1873·50	Dembowski,	259·76	259·95	– 0·19	4·08	4·12	– 0·04
1873·50	Wilson & Seabroke,	261·66	259·95	+ 1·71	3·65	4·12	(– 0·47)
1873·55	Talmage,	255·86	259·90	(– 4·04)	3·89	4·12	– 0·23
1873·66	Mädler,	260·66	259·79	+ 0·87	4·21	4·14	+ 0·07
1873·68	Gledhill,	259·16	259·77	– 0·61	4·1	4·14	– 0·04
1874·47	Main,	258·37	259·01	– 0·64	4·25	4·25	0·0

EPOCH.	OBSERVER.	θ_0.	θ_c.	$\theta_0 - \theta_c$.	ρ_0.	ρ_c.	$\rho_0 - \rho_c$.
		°	°	°	"	"	"
1874·48	Talmage,	258·27	259·01	− 0·74	3·13	4·25	(− 1·12)
1874·52	Dembowski,	258·77	258·95	− 0·18	4·16	4·25	− 0·09
1874·62	Wilson & Seabroke,	258·47	258·85	− 0·38	4·2	4·26	− 0·06
1874·66	Gledhill,	258·57	258·80	− 0·23	4·0	4·27	− 0·27
1875·42	Talmage,	259·87	257·91	+ 1·96	3·38	4·37	(− 0·99)
1875·45	Dembowski,	257·47	257·88	− 0·41	4·26	4·37	− 0·11
1875·53	Dunér,	259·07	257·79	+ 1·28	4·49	4·38	+ 0·11
1875·54	Schiaparelli,	257·87	257·78	+ 0·09	4·16	4·38	− 0·22
1876·45	Washington Abs.	255·88	256·91	− 1·03	4·66	4·50	+ 0·16
1876·51	Doberck,	257·28	256·85	+ 0·43	4·19	4·51	− 0·32
1876·53	Plummer,	258·08	256·85	+ 1·23	4·30	4·51	− 0·21
1876·53	Washington Abs.	257·18	256·85	+ 1·33	4·55	4·51	+ 0·04
1876·54	,, ,,	256·68	256·85	− 0·17	4·58	4·51	+ 0·07
1876·61	Talmage,	257·58	256·79	+ 0·79	—	—	—
1876·65	Plummer,	256·48	256·70	− 0·22	4·39	4·51	− 0·12
1877·64	Flammarion,	256·50	255·82	+ 0·68	4·32	4·65	− 0·33
1883·50	Perrotin,	251·40	251·40	0·0	5·54	5·44	+ 0·10
1885·49	,,	249·63	250·17	− 0·54	5·61	5·72	− 0·11
1887·605	Tarrant,	247·89	248·98	− 1·09	5·93	6·01	− 0·08

Assuming that the brighter component of the pair is the one in motion, the annual proper motion is 0″·15 per annum in the direction of position angle 47°·20. The magnitudes are 6·8 and 9·7, according to Dembowski, and the position for 1880·0 is R. A. $17^h\ 0^m + 28°\ 15'$.

VI.

ON THE DOUBLE STAR, 45 GEMINORUM = OΣ 165. BY J. E. GORE, F.R.A.S., Honorary Associate and Vice-President of the Liverpool Astronomical Society.

[Read DECEMBER 12, 1887.]

ASSUMING that the change of position in the components of this double star is due to uniform rectilinear motion, I have computed the following formulæ:—

$$\rho^2 = 8{\cdot}352 + 0{\cdot}0093\,(t - 1873{\cdot}55)^2,$$

$$\sec(87^\circ{\cdot}90 - \theta) = 0{\cdot}346\rho.$$

The following is a comparison between the measures and the positions computed from the above formulæ:—

EPOCH.	OBSERVER.	θ_o.	θ_c.	$\theta_o - \theta_c$.	ρ_o.	ρ_c.	$\rho_o - \rho_c$.
		°	°	°	"	"	"
1847·22	O. Struve,	130·70	129·0	+ 1·7	3·87	3·84	+ 0·03
1856·74	,,	119·35	117·1	+ 2·25	3·33	3·31	+ 0·02
1870·24	,,	89·70	94·1	− 4·4	2·89	2·91	− 0·02
1878·030	Burnham,	76·5	79·7	− 3·2	2·56	2·92	(− 0·36)
1878·214	,,	79·7	79·1	+ 0·6	2·34	2·92	(− 0·58)
1886·96	Hall,	60·7	63·8	− 3·1	3·18	3·17	+ 0·01
1887·118	,,	60·8	64·1	− 3·3	3·24	3·17	+ 0·07

As the star is a difficult object to measure, even with large telescopes (magnitudes 5 and 10·7), the above comparison may be considered as fairly satisfactory. Burnham found that "under the best conditions it was invisible with the 6-inch in 1875." The distance measures at the epochs 1878·03 and 1878·214 are evidently too small.

VII.

SECOND REPORT ON THE MARINE FAUNA OF THE SOUTH-WEST OF IRELAND. BY PROFESSOR HADDON AND REV. W. S. GREEN.

[Read DECEMBER 12, 1887.]

INTRODUCTION.

THE Dredging Committee, which published its "First Report on the Marine Fauna of the South-west of Ireland" in the Proceedings of the Royal Irish Academy in 1886 (2nd Series, vol. iv., Science, pp. 599–638), undertook to conduct a second expedition in the summer of 1886. The Committee consisted of Dr. E. P. Wright, A.M., Secretary, R. I. A., F. L. S., &c., Professor of Botany in Dublin University; Joseph Wright, Esq., F. G. S. of Belfast; Rev. W. S. Green, A.M., F.R.G.S., Carrigaline, county Cork; with A. C. Haddon, M.A., M.R.I.A., &c., Professor of Zoology, Royal College of Science, Dublin, as Secretary.

In the autumn of 1885 the Secretary was authorized to apply to the Government Grant Committee for assistance towards defraying the cost of the dredging operations. This application was granted early in January of the following year, and £100 was placed at the disposal of the Committee, under the following conditions, which had been previously offered to the Government Committee:—

"1. *With regard to Specimens.*—The Committee propose to give the first set of all specimens collected on the expedition to the Science and Art Museum, Dublin, and also duplicates of all those specimens which the Reporters of groups do not desire to keep for future reference or for anatomical purposes.

"In the case, however, of microscopic organisms (Foraminifera, Ostracoda, &c.), which require special and particular care in mounting, it is proposed merely to give the first set to the Museum.

"2. *With regard to Apparatus.*—The Committee further propose to deposit any apparatus or tackle bought with a portion of the Government grant in the above-mentioned Museum, where it will always be available for similar purposes."

Later on in the year the Royal Irish Academy granted a sum of £40 towards the expenses of the expedition.

A Meeting of the Committee was held early in 1886, when plans were laid for the proposed cruise, and the party was made up, and their several duties assigned to each member as follows:—

Rev. W. S. Green—To have sole control over the boat, crew, dredging machinery, and commissariat.

Lieut. W. H. W. Perrott, B.A., R.A.—To have sole control of all sounding and bottom temperature operations, in addition to the navigation and plotting the course.

T. H. Thomas, F.R.Camb.A.—To draw all the animals the Committee request him to draw.

J. W. Wright, Esq.—To secure samples of marine deposits for Foraminifera and Ostracoda.

H. W. Jacob, Esq., A.B.—To enter the lists of captures of each haul of the dredge, to keep the log, and to help in preserving the specimens.

A. R. Nichols, B.A., M.R.I.A. (in place of William Swanston)—To take charge of the tow-nets, to collect the surface organisms, and to record the air and surface temperatures.

C. B. Ball, M.D., F.R.C.S.I.—To have charge of the purely fishing operations, to examine all fish for parasites, and to eviscerate the fish and preserve their viscera in spirits.

Professor A. C. Haddon—To have the general direction of the scientific portion of the operations. To enumerate the general contents of every haul of the dredges, and to be responsible for the proper preservation of the specimens.

These general instructions were accepted, and as far as possible heartily carried out. The Committee again desire to express its great indebtedness to the skill and cheerful zeal of Lieutenant Perrott. The practical experience of Dr. Ball in matters pertaining to yachting and fishing proved most valuable: fortunately, his professional services were not required. Mr. Nichols further assisted in calculating logarithms for the navigation; and lastly, the Committee feel a debt of gratitude to Mr. Thomas for undertaking, from purely disinterested motives, to depict the interesting forms of life under conditions so unfavourable, and for the fidelity and beauty of his representations.

Mr. Green undertook to make all the requisite arrangements with the Clyde Shipping Company, to see to the provisioning of the steamer, and also to institute inquiries concerning the various kinds of warp to make dredges and nets, and the construction of a sounding machine.

All this entailed a vast amount of forethought and labour; and the other members of the Committee feel that whatever success may have attended the expedition, the credit is due in no small measure to their energetic and enthusiastic colleague.

The Committee have again the pleasure of expressing its high appreciation of the careful seamanship and ready good will of Captain Tobin, of the "Lord Bandon." The crew also proved to be anxious to assist, as far as lay in their power, the services of the skilled engineer being in constant requisition.

The details concerning the management of the vessel, and the nature and manipulation of the trawls and dredges, is given by Mr. Green. (Part II.)

The various groups of animals collected will be duly reported upon in detail by different naturalists.

PART I.

NARRATIVE OF CRUISE. BY PROFESSOR ALFRED C. HADDON.

We embarked at Queenstown, at 3.30 P.M. on Monday, July 5, 1886, and, sitting down to dinner, found that the lady friends of some of our number had remembered to ameliorate our condition by means of various dainties.

The change from hot and dusty railway travelling to the bright sea (the waves of which were just crisped by a slight breeze from the west) was most refreshing. As soon as the garments of civilization were cast aside for those of a more nautical cut, the serious operations of putting the finishing touches to the derrick and sounding machine commenced, all the trawls and other tackle were overhauled, and the fluids and apparatus for the conservation and storage of specimens put in order.

The sounding machine was first tested at 8½ miles south-west of Ballycotton Island, when 39½ fathoms was recorded. It was very satisfactory to find that the apparatus worked perfectly, and gave universal satisfaction. The dredge brought up several small specimens of Thyone, and other ordinary shallow-water forms.

We anchored that evening in Ballycotton Bay to prepare ourselves for a southerly run the next day. Before turning in, the tow-nets were put overboard, and this was done every night whenever it was possible. Before starting the next morning at 5 A.M., the tow-nets were found to contain some specimens of *Laodice cruciata*, *Pleuro-*

brachia pileus, and various small Crustacea such as Nebalia. A specimen of the parasitic larva of *Halcampa chrysanthellum* (cf. Proceedings Royal Dublin Society (N.S.), vol. v., 1887, p. 473) was found attached to the sub-umbrella of a Leptomedusoid. The tow-net gatherings, however, never proved to be particularly interesting, owing, probably, to the general inclemency of the weather.

Dredging commenced from 28 to 38 miles from shore, in the area locally known as the Nymph Bank. We were anxious to have a few scrapes here, as this may be considered historical ground, having rendered many rarities to the late Dr. R. Ball of Dublin. For the first time we saw a living specimen of the British Gorgonid (*Gorgonia verrucosa*): of this Mr. Thomas made a life-like sketch. The very short time we spent here proved that the ground is well worthy of a more minute study. A pale-coloured new species of Edwardsia (*E. tecta*, Hadd.), and two examples of the erect variety of *Epizoanthus papillosus*, associated with a Pagurus, were also obtained. This encrusting colonial Actinian entirely surrounds a dead gasteropod shell inhabited by a hermit-crab. The Epizoanthus has the remarkable power of dissolving away the hard molluscan shell, and replacing it with its own sand-impregnated tissues. The shelter of the Pagurid or Carcinæcium, as it is termed, thus comes to be formed entirely by the Actinian; and as the hermit-crab increases in size, the Epizoanthus colony extends at the same time, so that, unlike other hermit-crabs, those associated with the Epizoanthus have not to provide themselves with a new home after each moult. The most noteworthy capture at this station was a specimen of Neomenia. This is the first Irish locality for this genus, and also the second unequivocal British record. A form which he could not identify was found by Sir John Dalyell in the Firth of Forth, and named by him *Vermiculus crassus* (The Powers of the Creator, ii., 1853, p. 88, Plate x., fig. 11). This was renamed *Solenopus dalyelli*, by J. Koren and D. C. Danielssen in 1877 (cf. Ann. and Mag. of Nat. Hist. (5) iii., p. 327, for translation of the Paper referred to). Canon A. M. Norman found the type species (*Neomenia carinata*, Tullb.) in the Shetland Seas ("On the Occurrence of Neomenia (Solenopus) in the British Seas," Ann. and Mag. of Nat. Hist. (5), iv., 1879, p. 164).

It was our intention to dredge Labadie Bank, and to spend the night there; but the sea became rough, and most of the staff were disabled. As this prevented satisfactory work from being accomplished, we determined to make for a sheltered bay, and we reached Glandore late that night.

A little shallow-water dredging was done next morning in Glandore Harbour and Scullane Bay, and again further out some seven to eight miles south of Toe Head. Here we obtained a second small piece of *Gorgonia verrucosa*, and several specimens of a Pygnogonid, with their egg-capsules on *Hydrallmania falcata*. The bottom temperature was 49° F., the surface being 61°, and the air 63° F. The bottom temperature at the Nymph Bank was 48° F.

On the representations of Mr. Green, we decided to pay a visit to Lough Hyne, which is approached by a narrow sound between high rocks expanding into a small lake-like inlet below the hamlet of Barloge. A long, very narrow passage thence leads into Loch Hyne, which is an oblong marine lake, about half a mile long, imbedded in wooded hills, with an island in the middle containing a ruined building, known as O'Driscoll's Tower. Owing to the narrowness of the gorge leading to the lough, the tide rushes along like a mill-race. At low water, during spring tides, owing to a difference of level in the channel, there is a distinct waterfall of some four feet. The lough can only be entered or left with safety at certain states of the tide, but the level of the water in the lough itself varies very little with the tide; it is, in fact, reported to be practically tideless.

At one spot, resting on the rocks just below the surface of the water, were a number of the Purple Urchins, *Strongylocentrotus lividus*, the colours of which varied, as is usual, from purple to dark brown and dark green. Owing, probably, to their sheltered position, and consequent freedom from currents and large waves, these sea-urchins merely rest upon the rock, and do not excavate "nests" for themselves, as others do, on the exposed coasts of Clare and Kerry. This is possibly about the extreme eastern limit of this beautiful Echinoid on the southern coast of Ireland (see also p. 178 of Professors E. P. Wright and J. Reay Greene's British Association Report for 1858). Mr. Green drew our attention to the fact that the rocks here are covered with white and pink Nullipores, and that he has always found the Purple Urchin associated with these calcareous algæ.

Lough Hyne varies in depth, twenty-five fathoms being the maximum. The bottom deposit appears to be a dense fine malodorous mud. Oysters were formerly abundant; but these and other Molluscs were killed in large numbers, a few years ago, by spring freshets after a heavy fall of snow.

On attempting to leave the lough, we found the tide had turned, and the rapids of the channel were so boisterous, although it was only

an ordinary tide, that all but one had to land, and the boat was hauled along by a rope against the incoming tide.

This beautiful lough is worthy of a detailed investigation, both from a physical and biological point of view.

That night we anchored in Baltimore Harbour. On the 8th we left Baltimore for Dursey Sound, as the latter is the more convenient starting-point for a westerly run, and we were waiting for the swell to quiet down somewhat, it being our intention to stay a night or two at sea if at all practicable.

We had to put into Schull for bread and meat, and there we landed Mr. C. E. Robinson, C.E. of Torquay, who had accompanied us thus far. After trawling through Long Island Sound, we visited Crookhaven, a spot which Dr. E. Perceval Wright many years ago found to be a rich collecting-ground for Sponges and Coelenterates. (*Vide* British Association Report for 1858, and Gosse's Actinologia Brittannica, 1860, pp. 214 and 292.) We merely trawled with the Agassiz trawl off the Coastguard Station, and found the dense black mud there to be alive with innumerable specimens of Philine. Twelve species of Decapod Crustacea occurred—*Inachus dorynchus*, *Pirimela denticulata*, *Galathea andrewsii*, and other common forms. Rounding Brow and Mizen Heads, we crossed the mouth of Bantry Bay: from a depth of 37½ fathoms we dredged *Ophioglypha affinis*, and the new species of Halcampa, *H. arenarea*, which we first discovered last year, at the mouth of Kenmare River (*cf.* First Report, *loc. cit.*, p. 616); also another specimen of the form which was named *Chitonactis* (?) *expansa* (*loc. cit.*, p. 616); but for which the new genus of Paraphellia will be proposed ("Revision of the British Actiniæ," Trans. R. D. Soc., 1888). A small anemone which could not be identified was dredged that evening in Dursey Sound. The body was buff-coloured, with longitudinal white lines, the capitulum the colour of red lead, and the tentacles translucent white. It may be a variety of *Sagartia coccinea* (Müll.)

The weather looking promising, we decided to make an early start next day for the deep water, and the decks were cleared for action.

At 5 A.M., on Friday, 9th July, we left Dursey Sound, and steamed west half south of Dursey Head. About eleven o'clock we trawled in 108 fathoms, and brought up the first living specimens of the widely-distributed *Dorocidaris papillata* which any of us had seen. Numerous *Echinus microstoma* and a few *Spatangus raschi* also came up. On the latter were numerous specimens of a Caprella. *Galathea*

nexa also occurred. About four o'clock P.M. we had a successful haul with the Agassiz trawl in 325 fathoms. By this time we were fifty-three miles from the Durseys. The forms which came up this time were particularly interesting, and introduced a new Fauna to those who were only previously acquainted with the ordinary inhabitants of shallow water.

We obtained ninety-two specimens of *Pontaster* (*Archaster*) *tenuispinus*, and ten *Brisinga endecacnemos;* the latter most lovely and rare Starfish played us the annoying trick of casting off all their arms the moment they emerged from the water. We saw perfect specimens with their eleven delicate fringed arms in the tangles when below the surface of the water; but, immediately they emerged, the animals shivered, and the round flat disc was severed from the writhing arms. *Pontaster tenuispinus* has once before been obtained in British waters, three specimens being dredged by the "Knight Errant," in 1880, from Station 8, 540 fathoms in the cold area of the Faroe Channel (Proc. Roy. Soc. Edinb., Session 1881–82, pp. 670, 699). Several varieties of Echinus were dredged, having a decidedly dwarfed aspect, and two specimens of *Holothuria tremula*. This is the first occasion on which this brilliant vermilion-coloured Holothurian has been dredged so near to British coasts: later, we obtained it from shallower depths. Only a single specimen of the widely-distributed *Dorocidaris papillata* occurred, but that carried a new species of Actinian on one of its spines. This sea-anemone had a very pale-green-coloured body, studded with darker-coloured pointed tubercles; the tentacles were mainly brown in colour; it is a member of the new sub-family of the Chondractiniæ. It will be named *Chitonactis marioni*. A hermit-crab, with large smooth chelæ, inhabited the immature shell of *Cassidaria tyrrhena;* but we did not recognize the latter at the time. One fact was particularly striking, and that was the pink colour of the contents of the trawl. The Pontaster and the Brisinga were of a pale-pink colour, especially lovely in the latter; the claws of the hermit-crab of a delicate rose-pink. Nearly all the Echini had some reddish patches, and the Holothuria were considerably paler than any we afterwards found. The pale-green body of the anemone was complementary in colour to the prevailing tint.

At 6.30, the sounding machine registered 690 fathoms, and the Blake dredge was lowered. Shortly before 10 o'clock the wire-rope was wound up, but the dredge was left behind. This was our first loss: the reason for the mishap is explained in Mr. Green's report. Owing, probably, to some slight damage done to the outer glass

casings when being fitted into their brass carriers, both deep-sea thermometers burst, thus depriving us of the means for determining the thermal distribution of the forms we were dredging.

The sea was pretty calm all day, but there was a long roll from the south-west. As the weather was promising, we anticipated with eagerness the results of next day's dredgings. We steamed slowly all night, occassionally lying to, so that we might commence at 1000 fathoms the following morning.

The two or three more responsible members of the party were up by 2.30 A.M., and, sounding, found that we were in 1100 fathoms. The lard at the bottom of the sounding-lead was coated with Globigerina ooze. The enormous labour of turning the handle of the sounding machine by hand led to the simple device of connecting the drum of the machine with the donkey-engine at the bows by means of a cord; this arrangement proving perfectly satisfactory, was thereafter alone used. As soon as possible a small dredge was lowered, all our wire- and manilla-rope being put into requisition. Great care had to be taken during the whole operations to relieve the tension on the warp, as we had no accumulators. When the dredge was down, the rope, immediately after it left the donkey-engine, was twice turned round a timber head, and when the man there stationed saw that the rope was giving, a little fresh rope was payed off by the donkey, and the steamer was so handled as to reduce the strain. It took over three hours to haul up the dredge, and during this time the wind began to freshen and the sea to become lumpy. At 9.45 the dredge came up empty—a great disappointment after seven hours of hard work upon empty stomachs.

The steamer's course was put towards Valentia, the proposal being to dredge *en route* in about 500 fathoms and less, as it was evident our rope was insufficient for greater depths.

At 1.30 P.M. a blank was drawn at 480 fathoms, and about 5 o'clock P.M. a trawling was made some 42 miles from the Great Skellig in 160 fathoms. The above-mentioned species of Dorocidaris, Spatangus, and Holothuria were obtained; also a small specimen of *Ophiothrix lütkeni*, and three large examples of *Caryophyllia borealis* (*smithii*). Their coralla were 1¼ inch in height, and 1 inch to 1½ inch in their long axis. They formed most lovely objects when fully expanded, being of a translucent white colour, the tentacles speckled with opaque spots, and the disk with a bright yellowish grass-green waved line round the elongated mouth. Upon one of them was a sand-coated pink anemone, with an expanded base and

a long colourless capitulum, short conical pink tentacles, with a madder ring near their base: it will be known as *Paraphellia greenii*, so called after our colleague, the Rev. W. S. Green. This species, and the new species of Edwardsia (*E. tecta*), with other Actiniæ, will be described in the forthcoming "Revision of the British Actiniæ," Part I., Trans. R. D. Soc., 1888.

All day the wind had been rising, the sky was overcast, and the sea was becoming more and more agitated. By 3.30 P.M. the weather was so "dirty" that it was decided to put on "full steam," and, if possible, to make Valentia before nightfall. With oil-skins donned, all hands were busy stowing the gear, arranging the fishing-lines, sifting and washing the dredged-up sand, bagging the latter, and preserving specimens and writing their appropriate labels, ignoring the pitching of the steamer and the driving of the rain.

At 8.45 P.M. we were, by the log, still 8 miles west of the Skelligs, and the fog was denser. All hope of making Valentia Harbour that night being over, we had to spend the night beating about the mouth of Dingle Bay, and it was not till 9 o'clock the next morning that the fog began even partially to lift, and at 10 A.M. on Sunday morning we steamed into Valentia Harbour.

The Rev. A. Delap brought out to us a basket-full of letters and papers. In the afternoon we were warmly welcomed at the Parsonage, and gained much information concerning the Fauna and Flora of the Island and Coasts of Valentia—the whole family being much interested in local natural history.

On Monday morning, after receiving an early visit from the Delap family, and showing them our method of working, we put down the trawl on a sandy bottom and brought up a large quantity of sea-weed, and but little else; a fragment of *Eurynome aspera*, and one or two common Crustacea were obtained. Next we visited the picturesque islands of the Blaskets, and again crossing Dingle Bay we made for Ballinaskellig Bay, where we dredged and trawled; but the wind was too fresh all day to dredge successfully. In the evening we landed the Rev. A. Delap, junior, who had spent the day with us, and the most part of the party were very hospitably entertained by Mr. Butler of Waterville, who also made us an acceptable present of a salmon and some fine pink trout from his salmon-weir. The latter is situated on the stream which flows from Lough Currane to the bay, and this very weir is known, by documents in the possession of Mr. Butler, to have existed in the reign of King John. The weir is of

curious construction, such as is common in these parts, the plan of which is said to have been introduced by the Danes.

By 7.15 next morning we were abreast of the Skelligs, and the wind from the south-west was increasing. The prospect of success was so small, and the risk to the gear so great, owing to the rising seas, that the majority considered it futile to dredge; but Mr. Green, with his characteristic energy and enthusiasm, ruled it otherwise, and the Agassiz trawl was shot. As it happened, we obtained the largest and most varied haul of the whole expedition. Amongst other captures may be mentioned numerous large-lobed examples of the cup-like Sponge *Phakellia ventilabrum;* in cavities of a smaller sponge nestled lovely snowy-white examples of *Corynactis viridis*, the rim of the column being girdled with a pale-green band. Other specimens of this variously-tinted little Actinian, more brightly coloured, were growing on shells, Tubularia stems, and other objects, the most striking being a new colour variety, the column shading from yellow below to dark emerald-green above, with a greenish disk; the tentacles dark violet, their terminal knobs being pink. Amongst other anemones were the magenta-spotted white *Adamsia palliata*, associated with *Eupagurus prideauxii;* the pinkish-orange-coloured *Gephyra dohrnii*, a southern species we had introduced to the British fauna in our First Report; a brilliant cherry-coloured Sagartian, perhaps a variety of the former; considerable sized clumps of a cream-coloured Palythoa, and a large, handsome tuberculated anemone, with greenish body and white disk, and tentacles splashed with madder brown; the inner cycles of the tentacles were remarkably swollen at the base, the outer being without these basal bulbs. This fine addition to our fauna is the *Chitonactis richardi* of Marion, from deep water in the Bay of Biscay, and is also closely allied to, if not absolutely identical with, a species which has of late years been dredged in profusion from deep water off the coasts of New England, and which was named *Actinauge nodosa* by Professor Verrill; but it is not (as Professor Verrill believes) the same species as that described as *Actinia nodosa* by Fabricius, from Greenland, over one hundred years ago. Of Echinoderms we trawled an eleven-rayed specimen of *Solaster papposa*, a *Luidia sarsii*, a few *Astropecten irregularis*, large specimens of *Ophioglypha lacertosa*, large numbers of *Ophiopholis aculeata*, *Ophiocoma nigra*, and *Ophiothrix pentaphyllum* (*O. fragilis*), several *Brissopsis lyrifer*, and one *Antedon rosaceus*. Amongst other Crustacea were *Crangon vulgaris*, *Pandalus annulicornis*, *Eupagurus excavatus*, *E. cuanensis* (?), *Gonoplax angulatus*,

and *Xantho florida*. There were several repulsive-looking Pycnogonida, and numerous other invertebrates, the most beautiful among which was a delicate lilac-coloured Eolis, three-quarters of an inch in length, probably *Coryphella landsburgii*. A couple of fork-beard hake (*Phycis blennoides*), and three brilliant-red *Sebastes norvegicus* represented the vertebrates.

There appears to be a submarine ridge extending considerably out to sea from the headland between Bray Head (Valentia Island), and Bolus Head, of which Puffin Island, Lemon Rock, Little Skellig, Great Skellig, and the Washerwoman Rock are higher or lower peaks: the submarine portion is probably not exactly like a rocky ridge on land, but it is certainly hard ground, and seems to be particularly favourable for marine life, and it is possible that this area will be found to be one of the richest all round the British coast, or at least one supporting a most luxuriant Fauna within ready access.

The weather was getting worse and worse, and Mr. Perrott, who was as usual working the donkey-engine, was continually deluged with seas over the bow. By eleven o'clock it was deemed prudent to run back to Valentia, and the afternoon was quietly spent by some in preserving, in the pouring rain, the captures of the forenoon.

Although the gale was still blowing, on Wednesday morning an attempt was made to get on to the ground of the previous day, and as the sea moderated, a trial was made six and a-half miles west of the Great Skellig. Unfortunately, our valued curved dredge became jammed in the submarine reef, and the handles were torn away, leaving the dredge below. Dredging being found impossible in the open water, it was decided to make for Kenmare River, and to anchor that night in Dursey Sound, so as to be ready for a last attempt at the deeper water.

Thursday, July 15. As the wind had moderated, we started at 5 A.M., and steamed along a west-south-west course. At breakfast-time we were called up to witness a school of Dolphins. The swimming and leaping movements of these shapely Cetaceans and their metallic lustre were greatly admired; their graco, power, and celerity of motion, were quite a revelation of the possibilities of aquatic existence.

About 9.30 we lowered the Agassiz trawl, some thirty miles from Dursey Head, in 93 fathoms. By eleven o'clock the trawl was on board, with *Dorocidaris papillata, Echinus microstoma, Spatangus raschi, Ophiothrix lütkeni*, a beautiful mass of *Filigrana implexa*, and one specimen of the nodulated Actinian attached to the shell of a Pinna.

Another similar haul was made in 100 fathoms, thirty-five miles from coast. The trawl was out at 3.30 P.M. in 110 fathoms, forty-three and a-half miles from the Durseys. In addition to the above, we obtained one *Asterias rubens*, one *Luidia sarsii*, one *Astropecten irregularis*, and two *Holothuria tremula*—one being 12 inches long and 9½ in circumference. Polynoë (?) and Caprella (?) were found associated with *Spatangus raschi*. Six specimens of the above-mentioned nodulated sea-anemone were trawled, two of which had grown round a small Natica, tenanted by *Eupagurus cuanensis* (?), and the base of the other two formed a deep cup with a constricted orifice, which was filled with sand, and thus constituted a sand anchor of a type new to us. Of the eight large specimens of this form (*Actinauge richardi*), five possessed this modification, two had grown round a small Natica-shell, and one was attached to a Pinna-shell.

The next trawling was in 214 fathoms, fifty miles from land, and several specimens of the previously mentioned species of Dorocidaris, Echinus, Spatangus, and Holothuria, and *Pontaster tenuispinus* came up along with *Pandalus annulicornis*, and the rare *Munida rondeletii*.

The trawl was again shot about 8 P.M. in 265 fathoms, fifty-seven miles west, half-south of Dursey Head, and we were rewarded by obtaining a couple of very fine adult specimens of *Cassidaria tyrrhena*. The shells had a perfect and very thin outer lip, and a large delicate wing projecting from the inner lip along the siphon, almost at right angles to the long axis of the shell. Extreme length of shell, 93 mm.; greatest diameter, 61 mm. The animal was of a uniform, delicate pink colour. Mr. E. A. Smith, of the British Museum, gave me the following information:—"There is no doubt that your new British shell is a well-known Mediterranean and Atlantic species, which is, like most shells, known under several names. It is the *Cassidaria rugosa*, Linn. = *C. tyrrhena*, Chemn., and by some authors considered a var. of *C. echinophora*, Linn. The name most commonly applied to it is *C. tyrrhena*. Fragments of it were obtained by the 'Porcupine' expedition of 1870, in lat. 48° 6′ N., and long. 9° 18′ W., at a depth of 539 fathoms. This information has not yet been recorded; but when I complete Jeffreys' Report on the Mollusca of that expedition, I shall mention it."

Mr. W. H. Baily, of the Geological Survey of Ireland, on my communicating to him the discovery of this species, kindly lent me a couple of sketches, and a memorandum he had taken of a Cassidaria in the collection of the Rev. G. Basil Anderson of Dingle.

On my writing to him about this shell, Mr. Anderson very kindly

immediately forwarded it to me for my inspection. It proved, as I suspected, to be the species in question, and is a very fine and perfect specimen, its dimensions being: extreme length, 90 mm. (3⅝ inches); greatest diameter, 54 mm. (2⅛ inches). Mr. Anderson informs me that "the shell was taken in 1880, in a trawl-net, in the usual south-west ground, twelve or fifteen miles from Dingle, and six or eight miles north of Valentia Island (Co. Kerry). It was tenanted by a hermit-crab." The depth from which it was obtained would be about 40 fathoms. The fact that we trawled two living examples of *Cassidaria tyrrhena* off the south-west coast of Ireland dissipates whatever doubt there might have been concerning the Irish *habitat* of Mr. Anderson's capture, so that it is actually the first obtained British specimen of this handsome species.

I am indebted to Canon A. M. Norman for the two following references:—

Cailliaud, F. "Catalogue des Radiaires, des Annélides, des Cirrhipèdes et des Mollusques marins, terrestres et fluviatiles recueillis dans le département de la Loire-Inférieure." Nantes: 1865.

Page 180. "*Cassidaria tyrrhena* (Linn.). Hab.: dragué vivant à quarante ou cinquante mètres par les bateaux pêcheurs, entre Belle-Ile, Hoedic et le Croisic [Bretagne]. Cette espèce Méditerranéenne ainsi que l'*Isocardia cor* les *Triton nodiferum* et *cutaceum*, sont, pour nos des raretés qui habitent profondément quelques points au large de nos côtes."

Fischer, P. "Essai sur la Distribution géographique des Brachiopodes et des Mollusques du litoral océanique de la France." Actes Soc. Linn. Bordeaux (4), xxxiii., 1878. On p. 22, *Cassidaria tyrrhena* is marked off for region 2, which is: "Région Armoricaine ou du massif breton.—Le littoral très découpé de cette région commence au Cap de la Hague et de termine, en limitant le massif breton: le Golfe de Saint-Malo est entierèment compris dans des limites."

The late J. Gwyn Jeffreys ("The Deep-sea Mollusca of the Bay of Biscay," Ann. and Mag. of Nat. Hist. (5) vi., 1880, pp. 315–319), made the following record:—"No. 121, *Cassidaria tyrrhena*, Ch. Perhaps a variety of *C. echinophora*, L." (p. 318), and apparently he had also dredged it while on "the 'Porcupine' cruise of 1870, off the western coasts of Spain and Portugal" (p. 319).

Although this is not the place to enter upon a discussion as to the distinctness of this species from *C. echinophora*, it may be here mentioned that the Science and Art Museum of Dublin has recently acquired from the Marquis of Monterosato a fine collection of Medi-

terranean shells, amongst which are several specimens of *C. tyrrhena*, all of which are unmistakably similar to our form, and can be readily distinguished from ordinary specimens of *C. echinophora*. The following are the localities of the specimens of *C. tyrrhena* in the Science and Art Museum, Dublin:—Three specimens from Palermo, $2\frac{15}{16}$ in. long by $1\frac{9}{16}$ in. diameter; $2\frac{13}{16}$ in. by $1\frac{9}{16}$ in.; $2\frac{11}{16}$ in. by $1\frac{1}{2}$ in., respectively; two specimens of "var. *atlantica*" from off Arcachon, $3\frac{1}{8}$ in. long by $1\frac{13}{16}$ in. in diameter—one, at all events, being from a depth of 802 fathoms ("brasses"). Our specimens agree perfectly with the above-mentioned examples of "var. *atlantica*." This variety is a much larger and finer shell than the Mediterranean form.

The overlapping of species characteristic of the Lusitanian and Boreal regions off the south-west of Ireland has been noted before. Our two expeditions have advanced additional evidence of this fact. For example, of southern forms we found *Gephyra dohrnii* and *Ophiothrix lütkeni*, in addition to the well-known *Strongylocentrotus lividus*; while *Holothuria tremula*, *Brisinga endecacnemos*, *Pontaster tenuispinus*, and possibly *Actinauge richardi* represented the southward migration of northern species. This interdigitation of faunæ was, however, most markedly demonstrated, when in the same trawl a couple of brilliant *Holothuria tremula* were associated with two very fine specimens of *Cassidaria tyrrhena*, one of the most characteristic of the Mediterranean shells. I at once recalled the somewhat similar experience narrated by the Rev. Canon Norman, in his "Notes on the French Exploration of 'Le Travailleur' in the Bay of Biscay" (Ann. and Mag. of Nat. Hist. (5), vi., 1880, pp. 430–436): he states:—"A curious instance occurred of the meeting in the Bay of Biscay of species hitherto supposed to be confined to Scandinavia, with others regarded as eminently Mediterranean. The trawl had been down in 360 metres, and when taken up, out of it rolled one or two hundred large Holothurians, each about a foot long. It was at once evident that they belonged to two species; and further examination proved about two-thirds of them to be the rosy-coloured *Holothuria tremula* of Norway; the remainder, known at a glance by their light-brown colour and flattened side, were *Stichopus regalis* of the Mediterranean. They had apparently met on this neutral ground, and were living together on the most amicable terms."

It was quite late by the time the trawl was up, and we then steamed for Berehaven, where we arrived the next morning at 3 A.M., running before a high sea.

A little dredging was done in Berehaven on our old ground, but

with no new results except the finding of the first recorded Irish specimen of *Edwardsia beautempsii* (*E. callimorpha*); we also obtained *Gonoplax angulatus*, *Ebalia cranchii*, *Nika edulis*, and other Crustacea.

After trawling along Long Island Sound, we tried to make Baltimore Harbour that night; but as it was dark, and the weather turned quite thick, we were obliged to return to Schull.

On Saturday, the 16th, we started for Queenstown at 5 A.M. At 9.30 we passed the "Stags" of Toe Head, and arrived at Queenstown at 2 P.M.

SECOND CRUISE OF THE "LORD BANDON," 1886.

Log No.	Date.		Depth.	
31.	July	5.	39½.	8½ miles S.W. of Ballycotton. Sand and broken shells.
32.	"	6.	—	Ballycotton Harbour. (Tow-nets.)
33.	"	6.	52½.	28 miles from shore. (Lat. 51° 22½′ N., long. 7° 58′ W.) ? Nymph Bank. Gravel and broken shells.
34.	"	6.	55½.	10 miles S. of No. 33. (Lat. 51° 12′ 30″ N., long. 7° 59′ W.) More sandy than last.
35.	"	7.	4.	Glandore Harbour, W. channel. Seaweed, sand, broken shells.
36.	"	7.	14.	Scullane Bay, under Toe Head. Sand.
37.	"	7.	43.	13 miles S.W. of Galley Head. Sand, broken shells.
38.	"	7.	41.	8 miles S.S.W. of Barlogue. Rocks and sand.
39.	"	7.	0–20.	Lough Hyne. Fine, dense, foul mud.
40.	"	8.	3½–5.	Long Island Channel. Fine sand and seaweed.
41.	"	8.	3½.	Crookhaven (opposite Coastguard Station). Dense sticky mud.

SECOND CRUISE OF THE "LORD BANDON," 1886—*continued.*

Log No.	Date.	Depth.	
42.	July 8.	37½.	9½ miles S.W. of Castletown Berehaven. Sand.
43.	„ 8.	20.	Dursey Sound. Sand and seaweed.
44.	„ 9.	108.	38 miles W., ½ S. of Dursey Head. Fine sand.
45.	„ 9.	325.	53 miles do., do., do.
46.	„ 9.	690.	67 miles do,, do., do.
47.	„ 10.	1100.	Lat. 50° 53′ N., long. 11° 58′ W. Globigerina ooze.
48.	„ 10.	480.	Lat. 51° 14′ N., long. 11° 35′ W. Fine sand.
49.	„ 10.	160.	Lat. 51° 20′ N., long. 11° 26′ W.; 42 miles from Great Skellig. Fine sand.
50.	„ 12.	4–7.	Valentia Harbour. Sand and dead shells.
51.	„ 12.	17.	½ mile S. of channel between Nabro and Vickillane (Blaskets). Foul ground.
52.	„ 12.	20–35½.	Ballinskellig Bay, ½ mile E. of Bolus Head. Foul ground.
53.	„ 13.	70–80.	5–8 miles W. of Great Skellig. Fine muddy sand.
54.	„ 14.	75.	6½ miles do., do. Rocky ground.
55.	„ 14.	23–38.	Mouth of Kenmare River. Foul ground.
56.	„ 15.	93.	29½ miles W. by S. of Dursey Head. Mud.
57.	„ 15.	100.	35 miles W. ¾ S. of do. Sand.
58.	„ 15.	110.	43½ miles do., do. do.
59.	„ 15.	214.	50 miles W. ½ S. of do. do.
60.	„ 15.	265.	57 miles do., do. do.
61.	„ 16.	1–1½.	Castletown Harbour. Slushy mud.
62.	„ 16.	5–10.	Berehaven.
63.	„ 16.	10–20.	Do. W. entrance. Mud, sand, dead shells.
64.	„ 16.	5–6.	Long Island Sound. Sand, mud, seaweed.

INVENTORY AND COST OF APPARATUS.

In order to give definite information to those who might like to undertake a similar dredging expedition, the Committee consider it desirable to publish the following list of apparatus and account of expenses:—

	£	s.	d.
Charter of "Lord Bandon,"	90	0	0
Sounding machine, two coils of galvanized steel-wire, 22 B. W. G., breaking strain, 260 lbs., 1400 and 1300 fathoms, respectively (Newall & Co., Gateshead-upon-Tyne), £1 18*s*.; castings, springs, woodwork, and workman's time on machine, made the total (including spare reel of wire), about . .	6	10	0
500 fathoms 2½-inch manilla rope, ...	10	17	11
500 fathoms ⅞-inch flexible steel rope, ...	6	18	3
500 fathoms No. 8 telegraph wire, ...	1	8	0
20-feet beam trawl, strong net, lined with fine mesh; irons, 14*s*.; twine for nets, 22*s*.; beam, 0, . .	1	16	0
1 Agassiz double-trawl, 7-feet beam, tubes ¾″ diameter, and irons, 28*s*.; two outer and one inner finer net, ...	1	11	4
1 Blake trawl and nets (heavier iron than above), tubes 1¼″ diameter, ...	2	17	2
Half-moon dredge, £1 12*s*., 3 feet wide, and net, .	2	0	0
Chains for tangles, sounding lead, marline, &c., .	2	0	0
Cost of fitting up Derrick, &c., ...	5	17	9
Large iron reel for winding up wire rope, . .	4	10	0
Hire of chronometer, ...	0	5	0
Carriage, and various expenses	2	1	10
	£138	13	3
Part payment of thermometers, ...	1	6	9
	£140	0	0

PART II.

Report on the Sounding and Dredging Apparatus.
By Rev. W. S. Green, M.A.

In the summer of 1885 I received a letter from Professor A. C. Haddon, stating that he had been entrusted, in company with Mr. Joseph Wright of Belfast, and others, with a grant from the Royal Irish Academy for the purpose of dredging for marine animals off the south-west coast of Ireland, and asking me to undertake the general management of the expedition. Immediately I entered into negotiations with the late Queenstown Towing Company, and secured the use of their paddle steamer, "Lord Bandon," for a period of six days. The rope and dredges were brought to Queenstown on the day of sailing (August 4th) by Professor Haddon and Mr. Wright. I had had a small surging drum fitted on the intermediate spindle of the steam-windlass, which gave greater speed in heaving-in, and had also constructed a small beam trawl, with fine-mesh net. A report of this expedition having already been published, it is unnecessary for me to enter into details; suffice it to say that the general conclusions I came to with regard to the working of our gear were briefly these:—

Sounding with hemp-cord was too slow, and our dredges, more suitable for obtaining the smaller forms of marine life, were so quickly filled with mud that no room was left for the larger animals.

In 1885 our deepest work was in 120 fathoms. Since the conclusion of that expedition, a larger grant was entrusted to our Committee with a view to prosecuting our researches to a greater depth, and I was again able to secure the use of the "Lord Bandon" from her new owners, the Clyde Shipping Company. As we could only have her for twelve days, it was obvious that our gear should be the best that the small amount of money at our disposal could provide.

Captain Sigsbee's book I found most valuable; and I came to the conclusion that in order to secure celerity in soundings, we must have an automatic, steel wire sounding machine, like that in use in the United States Navy, the principle of which was devised by Sir William Thompson; that for gathering the larger forms of life, the American double-trawl was the best implement, or at all events a dredge made on the same principle; and lastly, that we must try to work with a steel wire rope, instead of one made of hemp.

The day fixed for the sailing of our second expedition was July 5th,

1886, and in order that all things should be ready by that time I commenced preparations in the month of January. Correspondence with various manufacturers of material occupied no little time, so that in the end I found that I had not commenced work a day too soon. The result has shown that rapidity of action and efficiency in gathering objects were gained to a considerable extent. The details of construction and working of apparatus will now be given.

THE "LORD BANDON."

The steam-tug "Lord Bandon," which we were able to hire from the Clyde Shipping Company, is a paddle steamer of the following dimensions:—

Length, ...	122 feet.
Breadth, ...	19 „
Depth from deck to bottom of hold, .	10 „
Gross tonnage, ...	154 tons.

Two engines, side lever, surface-condensing cylinders, 30⅝"; length of stroke, 54"; horse-power, 95 (nominal); two boilers.

Steam Windlass.—This steam windlass was altered to meet our requirements in the following manner:—On the intermediate spindle a small surging drum was fixed, which revolved at a high rate of speed, and so enabled us to wind in our dredge rope at a rate of 50 fathoms per minute when the strain was not too great. On the lower spindle a very large iron surging drum was fixed; this was about four feet in circumference, and well calculated for winding the steel rope without injury.

Towing Sheave.—Over the stern projected two beams of wood, supporting a large iron sheave on which the dredge rope worked; the rope passed from this to the bridge, over which it was conducted on rollers to the donkey-engine; it passed thence to the iron reel which was fastened to the deck beneath the bridge. Close to the towing sheave in the stern a Derrick was constructed; this proved most useful for lifting the trawls and dredges on board.

The steam-whistle in front of the fore-funnel was utilized for signals from the stern (where one hand kept watch over the dredge rope) to the men at the donkey-engine in the bow. This was done by a long cord from the whistle to the stern Derrick: one blast meant "stop"; and, if stopped, one meant "go on heaving."

The crew consisted of the captain, chief engineer, and eight men, all told.

Sounding Machine.

Sir William Thompson was, I believe, the first to use fine steel wire on a reel with register on axle for measuring depths. His method has been tested on a large scale by the American Government, and the celebrated soundings of the United States American frigate "Tuscarora" were made with a machine on this principle.

Captain Sigsbee improved upon Sir William Thompson's apparatus in various ways, chiefly by the addition of an accumulator; and so far as was possible with the funds at my disposal I copied Captain Sigsbee's machine in constructing an apparatus for our expedition.

Our machine consisted of a cast-iron reel, 17 inches in diameter, with a groove, 2 inches wide, on which was wound the steel wire. A second groove, V-shaped, was for a friction-line which controlled the speed of the reel. A screw-thread on the axle engaged the cog-wheel of a register which recorded revolutions.[1] The wire, on leaving the reel, passed over a wheel supported by spiral springs capable of bearing a strain of 180 lbs. When the sounding-lead was hanging on the wire ready for or during a sounding, these springs were at stretch; to the frame of this wheel the friction line was secured, which, after passing through a pulley, passed over the friction groove of the reel, the other end being made fast below. The effect of this arrangement was, that so long as the weight of the sounding-lead was in suspension the wheel was borne down, the friction line kept slack, and the reel free to revolve; whereas, the moment the lead reached the bottom, the springs were released, the friction line pulled taut, and the reel so gripped by it that it must cease to revolve. The register could then be read, and the depth ascertained.

In the greater depths we utilized the friction groove for a rope belt to the donkey-engine, and so hauled back by steam. The lead used was an ordinary one of 15 lbs.; this weight at least was necessary in order to bring the springs into action. We did not find it necessary to use a heavier one, nor to resort to a Fitzgerald sounding-rod with detaching weight, which we had on board.

On all previous occasions on which soundings have been made with wire, the kind used has been piano wire, 22 Birmingham wire gauge.

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[1] Amongst his many other services, we must thank W. H. W. Perrott, Lieut. R.A., for making this register and its fittings.

This wire is supplied in lengths of from 100 to 400 fathoms, with a tensile strength of from 200 to 240 lbs. Great care is required in making the splices, which are always a source of weakness, and not being galvanized, the reel, when not in use, has to be immersed in a tank of lime water or oil to preserve the wire from rust.

Wishing to avoid the trouble and danger of splices in the wire, and also the carefulness required to preserve it from corrosion, I entered into corespondence with Messrs. R. S. Newall & Co., Gateshead-upon-Tyne, and they were able to supply me with two pieces of galvanized steel wire, 22 Birmingham wire gauge—one piece of 1400 fathoms, and the other of 1300 fathoms. This wire had a breaking strain of 260 lbs.; we had no need of splices. One piece only has been used; and though it met with various sharp nips from slight accidents in working, and although it was subject to very severe strain when it was being reeled in by steam while our vessel was going full speed ahead, it seems quite uninjured.[3] The greatest depth to which we sounded was 1100 fathoms. Between the lead and wire was a stray line of stout cord, 10 fathoms in length. This was necessary in order to avoid the risk of the wire reaching the bottom, where it would get kinked and then break, and to this stray line a thermometer was occasionally attached.

Our spare piece of wire was coiled on a duplicate reel, which was ready to slip on to the axle in the place of the other in case of an accident.

The register on the axle of the sounding-reel did not, of course, record fathoms, it merely recorded revolutions; and the length of wire represented by one revolution varied in proportion to the amount of wire on the reel. In order to discover the depth, it was necessary to construct a scale, reducing revolutions to fathoms: the scale was afterwards converted into a diagram with curve.

In all this portion of the preliminary work I have to thank Mr. T. H. Poole, C.E., for the great assistance he rendered.

The plan we adopted in constructing the scale was as follows:—The sounding machine with reel empty was set up in position with register on axle at zero. On a turn-table, a little distance away, the coil of wire was placed; between these a wheel, one fathom in circumference, was set up. This wheel was also provided with a register which started at zero; 50 fathoms of wire were then carefully measured against an even wall, then passed over the fathom-wheel, and wound

[3] The same wire was used again this year (1887) for sounding and temperature observations in Dublin Bay, and is as good as ever.

up on sounding-reel; when the 50 fathoms had passed, the registers were read and the readings noted. Reeling on to the sounding-reel was then proceeded with; and at every 50 fathoms recorded by the fathom-wheel the register on sounding machine was noted. This was done for the whole 2700 fathoms of wire, and gone over a second time for fear of error.

Dredge-rope.

On our expedition in 1885 we used hemp and Manilla rope; but as we wished to go into deeper water in 1886, the question arose—Should we continue to use hemp, or should we get a steel wire rope? So far as I could gather from the experience of others, and notwithstanding the fact that the great work of the "Challenger" was done with hemp, the arguments in favour of steel seemed conclusive, and to us, with only a limited time at our disposal, the speed gained in each operation when wire rope is used seemed of immense importance.

Against attempting to use a steel rope, the following considerations had to be carefully thought over:—We could not afford to fit out our steamer with expensive reels, and a special donkey-engine, like the American steamers and the "Talisman." In the case of the latter vessel, although they had everything that could be considered necessary on board, on one of the first occasions on which the wire rope was used the breaks proved insufficient, the wire went out by the run, and only that the end was made fast, it would have been lost. Captain Sigsbee also spoke of similar difficulties, and of the dangers arising from kinks forming in the rope. Taking all this into consideration, I determined to get 500 fathoms of flexible steel-wire rope, $\frac{3}{4}$-inch in circumference. I felt sure we could keep this length under control; but with the evidence before me, I did not think it prudent to risk a greater length with the machinery at our disposal. Our wire rope was made by Messrs. Barton & Co., Glasgow. It was smaller than that used on board the "Talisman," her rope being $1\frac{1}{8}$-inch circumference. It was in every way most satisfactory, and it was not given to kinking until it had been used in conjunction with a $2\frac{1}{2}$-inch Manilla rope.

To stow this rope on board I had a strong cast-iron reel, made by Messrs. George Perrott & Sons, Cork, furnished with a friction break, and bolted to the deck, fore side of the engine-room. Lest the break on the reel should not prove sufficient, the wire rope passed from it to the surging head of the windlass (which was thrown out of gear with the engine);

round this it made two turns in the direction opposite to that necessary for heaving-in: the strain could thus cause the windlass to heave round; but the friction was so great that one hand on the break of the reel could always check it, except when the dredge or trawl had fouled some obstacle on the bottom: the strain then overcame the friction break, and warned us to haul in. As we did not use an accumulator, this plan proved most satisfactory. The friction on the windlass could easily be increased, so that we could without difficulty have managed a very much longer wire rope, and the constant regret was that we had not 1500 fathoms of it on board. It was found necessary to fix the reel at a good distance from the donkey-engine; for, if too close, the rope could not be swayed to and fro, and so stowed evenly on the reel.

Lest the wire rope should meet with an accident, we provided ourselves with a similar length of 2½-inch Manilla rope, which I arranged to re-sell at half price when we were done with it. This I hoped might also with safety be used in conjunction with the steel rope, and so give us a length of 1000 fathoms, and also that its buoyancy would counteract the strain caused by the weight of the wire rope. We tried this combination once, but never again, as the twist of the manilla rope passed into the wire rope and caused it to kink, and become almost unmanageable, and in the end the wire rope had to be cut and spliced to get rid of a number of bad kinks which had formed in one portion of it.

500 fathoms of steel fencing wire, No. 8 Birmingham wire gauge, which we also brought with us, hoping that with it we might at small cost increase the reach of our dredges, proved a failure. It was strong enough, having a breaking strain of 1200 lbs. It paid out well, and with it at the end of our steel rope we had the dredge working the bottom in a satisfactory manner at a depth of 680 fathoms; but, on stopping the steamer's way to haul in, kinks must have formed, for the wire broke close to the dredge and three badly-jambed kinks were close to the fracture.

Had the weather given us a chance to try again, I believe the wire might have been worked safely, by taking the precaution to attach a weight to its lower extremity to keep it stretched, and have the dredge connected with it by about 50 fathoms stray line, so that the wire might be kept from reaching the bottom: its cheapness and strength were two recommendations.

We were thus compelled to content ourselves with dredging and trawling in depths accessible by means of our wire rope alone. In these depths the results were satisfactory, and the speed at which we

worked may be judged from the following records extracted from the log of two successful hauls:—

Depth in Fathoms.	Dredge.	Length of Rope out.	Time in Minutes.		
			Descent.	Ascent.	On bottom.
190	Agassiz trawl and dredge attached.	300	10	20	20
325	Ditto.	570	20	15	45

The time occupied in paying out and hauling in depended on many little circumstances which occasionally combined to delay the work; for instance, in the leeing of the vessel the rope might get too broad to port or starboard, and we should stop heaving-in while the paddles gave a few turns.

Trawls and Dredges.

Twenty-foot-beam Trawl.—One trawl this size was used occasionally for fishing in bays, and at moderate depths the floor of the net and tail of the purse were lined with small-mesh net, so as to retain small objects. This, and all our other nets, were tanned.

Blake Double Trawl.—The difficulty of landing the ordinary beam trawl right side up on the bottom in considerable depths of water led to the invention of the double trawl provided with two foot ropes, so that it matters not which side reaches the bottom first. To Captain Sigsbee and Professor Alexander Agassiz is due the credit of planning this implement. This trawl was used with much success on the "Talisman" Expedition. Our one was 7 feet wide by 2 feet deep. Length of bag, 12 feet.

Agassiz Trawl.—One of these trawls proved to be the best engine of all those on board for catching the larger forms of life. It differed from the former only in the mode of attachment of the foot ropes, which gave them a deeper curve. The nets of both trawls were of small-mesh net size, ½ inch from knot to knot, outside which was a second net of heavy trawl twine, and they were furnished with internal funnels to prevent fish, &c., once in from returning to the mouth and escaping.

Dredges.—The "Ball dredge" must always, in some form, take a

prominent position in any outfit for deep-sea investigation, as being a certain means of obtaining specimens of the bottom. Seven of these dredges were on board, those we used being provided with bags of sackcloth.

These dredges were admirably adapted for bringing up mud and sand, but as they filled themselves at once, by digging into the sea bottom, it was desirable to have a modification of form which would be better calculated for scraping the surface of the ocean floor.

The Blake Dredge was devised by Captain Sigsbee with this end in view. Its mouth, 3 feet wide, is similar to the ordinary Ball dredge, except that the scrapers are perfectly parallel, and not flaring, but its special peculiarity is the iron frame attached to the back, which keeps the whole machine on the surface of the bottom, and also holds the net in position, making it impossible for it to turn over, and foul the mouth of the dredge. Of this form we had one on board; it was provided with a heavy rake which could be attached in front. We soon gave up using the rake, as we could discover no evidence of its being an advantage in working.

This dredge, after doing good work, was lost in a depth of 680 fathoms, owing to the steel wire breaking. The largest dredge we had with us we have called the *curved dredge;* it was 4 feet wide by 6″ deep. The scrapers were made of two plates of iron, 6 inches wide, with a deep curve cut out. This curve formed the scraping edge, and possessed many of the advantages, of the curved foot rope of the trawl. It was heavier in proportion, sank better, and possessed many of the advantages of both dredge and trawl, while, owing to its curved mouth, it could not dig into the mud. Two iron bars were hinged on to the sides, and when in use these turned back, and were lashed to the tail of the net, thus precluding the possibility of the dredge going down foul. The bag was composed of small-meshed net, ending in a bag of sackcloth, and provided with a funnel. This dredge did its work well, bringing up both large and small forms of life, but it was lost under circumstances which I shall detail in next section.

Experiments were made with a circular dredge, designed and lent to us by Mr. C. E. Robinson, C.E., of Torquay, which seemed to be, on the whole, favourable. It was well calculated for digging deep into the mud, and so getting at Molluscs, &c., living beneath the surface. It took, however, a very heavy grip of the bottom, and we felt that it would endanger our rope, except when the sea was smooth.

Tangles were always attached to the trawls and dredges; they were

made of pieces of chain, 4 feet long, with strands of rope rove through the links, and then fretted out.

Sorting-trough.

A sorting-trough similar to that used on board the "Talisman" was provided by the Science and Art Museum of Dublin, for receiving the contents of the dredges. It was furnished with a series of sieves, and was carefully rinsed with sea water after each dredging, so that errors might not arise from assigning wrong stations to the various species obtained.

Working of the Gear.

When a sounding was made, and depth ascertained, the dredge and trawl were at once sent down. The plan which we found to work best was to attach a small dredge, with sackcloth bag, by a stout lanyard, to the thimble at the end of the dredge-rope, to which also the bridle of the Agassiz trawl was made fast; it thus scraped in front of the trawl, turned up the ground a little, and secured a good sample of the bottom. It did not injure the working of the trawl; for on one occasion, when this plan was adopted, in a comparatively brief haul we had no less than ten fish of various species, besides the usual assortment of Echinoderms, and lower forms of life. The dredge was also useful as a means for telling when the trawl was on the bottom, as its biting could easily be detected by a hand placed on the wire rope; whereas the runners of the trawl caused an almost imperceptible vibration in the greater depths. The sounding being completed, and the trawl ready, the first thing done was to pass the end of the wire rope to the donkey-engine, take a half turn on the surging drum, then pass the end over the bridge-rollers, and shackle on the dredge and trawl. The block of the derrick was then hooked on to a strop on the trawl, held in place by a greased marline-spike, to the eye of which a lanyard was attached. The fall was manned, the trawl hoisted high in the air, swung clear of everything, and so was borne by the derrick till the bridle was placed in the towing sheave. Then the word was given to lower away from the derrick. The steamer going easy ahead, the moment the net touched the water it trailed astern; when all seemed clear, the marline-spike was brought out by a smart jerk on the lanyard, and the trawl thus released, plunged into the sea, and was quickly out of sight astern, while the wire rope ran out over the sheave at a rapid rate. Warned

by Captain Sigsbee's experiences in working the wire rope, I was always careful to keep easy way on the steamer, until I thought that the trawl was on, or close to, the bottom. Then, if the breeze was fresh, we set the jib, which kept the ship's head off the wind, and caused her to drift to leeward at a rate sufficiently fast for working the trawl. When the swell was heavy we worked in the reverse direction, steaming slowly to windward. The result of our plan of working was, that we never had a foul trawl or dredge, and we were not troubled by the wire rope kinking while in the water. The kinks which did form, after use with Manilla rope, were on deck, between the donkey-engine and reel.

The weather, on the whole, was unfavourable for our work; on one day only (that on which we steamed out to deep water) was the sea fairly smooth. A south-westerly gale brought in broken weather and a heavy sea. A large amount of coal and of time was, in consequence, expended in steaming to and fro to the dredging ground, and a very short time comparatively was at our disposal for actual dredging.

To illustrate some of the difficulties we had to contend with, I shall conclude my report with an account of the loss of our curved dredge.

During the south-westerly gale, the sea at the time running very high, we risked two hauls—one with the curved dredge and one with the Agassiz trawl—in about 80 fathoms, off the Skelligs; both hauls were wonderfully rich in interesting forms of life; but we had to run for the shelter of Valencia Harbour. Next day the wind had shifted to the north-west, and, though still blowing hard, we determined to attempt another haul on the same ground.

The sea was running higher than on the previous day, and topping a good deal. On reaching the ground, I determined to use the curved dredge; and as the donkey-engine could not be worked if we went head on into the sea, I had to shoot the dredge running before the sea. When enough rope was veered, I wished to stop the engine; but though the jib was set to keep her head off, the captain considered that with the sea running nearly as high as the top of our funnels, the risk of a broach to was too great. I was therefore compelled to vere more rope, and let the engines continue working. This gave us too much way; the dredge tore away over the ground at a great pace, and, when we hauled in, the iron arms of the dredge came up, but the body of the dredge and net were left behind. Further attempts in such weather being useless, we sought the shelter of the Kenmare River.

Being anxious to make this account of our gear and its management as useful as possible to others who may engage in similar work, and who wish to do it económically, I have been careful to lay full emphasis on our misfortunes as well as on our successes.

The ground we investigated was particularly interesting, and the deeper water gave numerically better results than that inside the 100-fathom line; and, of course, the deeper we went, the rarer were the animal forms obtained.

The gear we had with us worked well, and I feel certain that with such gear, but with 1000 fathoms more wire rope, and moderate weather, most interesting work would result from a fortnight's dredging off this south-west corner of Ireland.

VIII.

NOTES ON A COLLECTION OF NATIVE WEAPONS AND IMPLEMENTS FROM TROPICAL WESTERN AUSTRALIA (KIMBERLEY DISTRICT). BY EDWARD T. HARDMAN, F.R.G.S.I.; of H. M. Geological Survey; late Government Geologist attached to the Kimberley Surveying Expeditions, 1883 and 1884. (Plates I., II., and III.)

[Read FEBRUARY 22, 1886.]

WHILE engaged for some two years on a Geological Survey of parts of Western Australia, I made a small collection of native weapons and other implements. The following short description of them may be interesting to the members of an Academy which has always strongly fostered the study of ancient implements, weapons, and costumes.

The specimens exhibited and described in this Paper are not numerous, as it was by no means easy to induce the natives to part with articles which must have cost them much time and trouble to manufacture with the rude means at their disposal. But I have been able to secure some specimens which bear such a remarkable resemblance to ancient Irish weapons, that they may possibly be of some value as throwing a little light on the manner of, and the mode of, using the stone and other implements of pre-historic times.

Not alone from this point of view are these instruments worthy of notice, but in showing, as it were, the dovetailing of ethnological habit from the time only recorded by a kitchen-midden down to our own days.

How many years ago the flint implement-makers of Britain and Ireland lived we do not precisely know; but it is agreed on all sides that many thousands of years have elapsed since the stone age in these countries. It is therefore the more notable that some of the weapons and implements described in this Paper exhibit forms and figures familiar to all, both as preserved in the Museum of the Royal Irish Academy, and as depicted in the well-known works of Wilde, Evans, Lubbock, Lartet, Pengelly, and Ferguson.

The resemblance of these Australian stone spear-heads, hatchets, chisels, and bone implements, together with the character of the orna-

mental work on some of the wooden instruments, is so strikingly akin to those of Irish pre-historic times, that I think it possible some of our best archæologists might be deceived by them. And yet they are things of yesterday. They are not only recent, but most recent. For instance, some of the spear-heads are made of bottle-glass, an article unknown to the natives of Kimberley four or five years ago. Two of these were made for my instruction in the art by two natives of Kimberley. The process was very simple. The native having obtained a portion of a broken bottle, knocked off a piece of suitable size. He then procured a rounded pebble of the rough iron-sandstone, of Carboniferous age, so very common in this part of the country. This was slightly rubbed on another stone, so as to give it a "bite." The next requisite was a small piece of wood. The native now seated himself, placed the wood under his toes, and the piece of glass—resting edgeways on it—between the great and second toe. He then, with light blows adapted to the nature of the flake he wished to strike off, deftly chipped the glass into its first rude leaf-shape form. This being accomplished, lighter blows were given, until a certain amount of finish was obtained; then the fine point was gradually formed, and the delicately-serrated edge, by slight taps with a smaller and a flat-edged stone.

The specimens I refer to are somewhat rude in appearance, having been made rather hurriedly, in order to show me the process of working. Still it seems almost incredible that so brittle and treacherous a substance as glass could be worked into the form exhibited by the aid of such simple instruments.[1] (See Pl. I., fig. 12.)

The whole operation did not occupy more than half an hour.

That the natives now use these glass spear-heads in actual warfare is shown by a sample I have, which was attached to one of their war-spears.

Another specimen, made from the glass of a brandy-bottle, and found, together with some highly-finished flint spear-heads, at a native camp, attests the wonderful delicacy of touch and sense of symmetry which the so-called degraded Australian savage possesses.[2]

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[1] Since writing this sentence I have met with a passage in Mr. R. Brough Smith's work on the *Aborigines of Victoria*, in which, referring to the stone spear-heads of Northern Australia, he says, that it is "difficult to believe that skill could produce from pieces of stone, by percussion only, such beautiful weapons."—*Condensed quotation.*

[2] This specimen is of a very beautiful leaf-shape, and worked to a fine and delicate point. (Pl. I., fig. 7.) The point has unfortunately been broken off.

If we compare the extreme simplicity of this method, and the beautiful results produced, with the process of the "flint-knappers" of Brandon, as described by Dr. John Evans, in his "Ancient Stone Implements," for the manufacture of "strike-a-light" flints, in which manufacture four steel hammers and one steel chisel are required, I think we must come to the conclusion that the Australian savage is a somewhat unappreciated man.

Dr. Evans points out the facility with which flakes may be produced from flint by means of a rounded pebble used as a hammer, not necessarily attached to a handle, but even when simply held in the hand. He also remarks that "proper attention has not being paid to the hammer-stones, which, in all probability, occur with the chippings of flint."

This conjecture with respect to pre-historic flint-works is thoroughly borne out by what I have observed in the Kimberley district. Frequently we came on deserted native camps in the river beds, where it could be seen, from the number of flakes lying about, that some of the men had been engaged on the fabrication of spear-heads; and invariably along with these flakes were rounded pebbles, evidently used as hammers, and in the correct use of which I was initiated by the natives who manufactured the glass spear-heads just described.

The primary process of obtaining the flint-flakes has been already described as in practice amongst the natives of the Victoria River, northern territory of South Australia. In about the same latitude in which we were exploring, but many miles to the eastward, Mr Augustin G. Gregory, who explored this district in 1855–6, found the ground in one locality strewn with fragments of flints and imperfectly-formed weapons. Mr. Bains explains the method of obtaining the flakes. According to his account the agate, or flint, is struck upon a larger stone in such a manner as, after some trials, to strike off suitable pieces for operating on further; but it would appear from his description that these natives are quite satisfied if they succeed in splintering off a flake sharply tapering to a keen point, and possessing a thick midrib.[3]

Mr. Brough Smith[4] appears to confirm this account, as he figures a spear-head from Northern Australia, which is very rude in appearance, and evidently merely a flint flake, not a finished spear-head like those I have seen from Kimberley.

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[3] Evans, *op cit.*, p. 24. Also *Anthrop.*, Rev. vol. IV., p. civ.

[4] *Aborigines of Victoria*, R. Brough Smith.

However, I have seen some specimens in the Melbourne Museum, as I recollect, from this part of Northern Australia resembling the ruder examples I possess, but not showing the finer finish of the better samples.

I may mention here that agate, calcedony, and quartz, both as vein-quartz and rock-crystal, are exceedingly abundant in Kimberley, ranges of hills, sometimes extending five or six miles, and even more, being composed in the upper portion of pure white calcedony, with moss agates and various other forms of quartz, the result of the alteration, by pseudomorphism, of the limestone of which the main portion of these particular ranges of hills consist.

From these agate hills the natives obtain the material for the manufacture of their flint implements, often utilising the rounded pebbles of agate carried down from them which abound in the beds of the rivers, but sometimes making these hills themselves at once the source and workshop. A small outlying range of agate hills on the Mayaret River, in about lat. 18·3° south, was apparently one of their chief resorts, as the summit of one of the hills was covered with fragments of flints and rejected flakes; and I thought it appropriate, therefore, to name an extensive range to the north, of which these agate hills are a part (being only divided by the river), Lubbock Range—after the author of "Pre-historic Times."

The impossibility of carrying away many specimens of these implements in a country, and under circumstances where every ounce of additional weight was a matter of deep consideration, was a source of deep regret.

It is most interesting to compare these beautiful specimens with similar flint weapons of pre-historic times as figured by Lubbock and Evans. It will be seen that these represent the highest form of projectile flint heads, or the leaf-shaped javelin form. A figure in "Pre-historic Man" almost exactly anticipates the shape of these Australian barbs, and the inference that the pre-historic weapon was used as an arrow or javelin is fully corroborated by the usages of the Australians, who use their spears as projectiles, either throwing them simply by hand, or with the assistance of a "wommerah," or thrower, an instrument which is to all intents and purposes a primitive bow, and affords the means of giving strong initial velocity to these javelin-like weapons.

My collection of spear-heads of various kinds shows a curious admixture, illustrating the adaptability of the modern savage to circumstances.

Separately they would seem to be representatives of the Palaeolithic, Neolithic, bone and iron ages.

There are three sets of mineral spear-heads. The first is formed of agate or chalcedony, well shaped, but rudely finished. These would seem to belong to a very different age, or to a distinct race of men, in which, or by whom, the very beautiful set of heads in the next section were formed. But these belong to the same age and people, and are but the finished production, worked up at the owner's leisure.

A native's kit, which consists of a piece of "paper bark" from the capput-tree,[5] always contains a few of these roughly-chipped spear-heads (Pl. I., figs. 1 and 3), and he works them up into the finely-pointed and delicately-serrated article at a convenient time.

We often surprised parties of blacks in their camps along the river beds, when the men were engaged in shaping the first rude conception of a spear-head into the orthodox and deadly weapon.

One cannot help being struck by the very symmetrical shape and the delicate finish of the completed spear-heads (Plate I., figs. 4, 5, 6). The central figure on Plate I. is especially worthy of notice (Plate I., fig. 2). This is formed of dark-green agate.

Next to these come the most modern, namely, those of glass. These exhibit alike the progress of civilization, and the deadly presence of the brandy-bottle.

The rate of colonization in certain parts of Western Australia can be roughly estimated by the quantity of bottles found in the sand. A bottle once emptied is considered to be of no further use, and is promptly chucked out; no one dreams of returning empties even in the large towns, and in the small ones you can always track your way to the best hotel by the accumulating glass.

The natives were not slow to discover that glass makes a formidable offensive weapon. In Queensland and South Australia they interfere seriously with telegraphic communication, by stealing the glass insulators as material for spear-heads. And when the white man appeared in Kimberley, and brought his inevitable brandy-bottle, it was quickly utilized, as shown in the specimens here exhibited.

Another species of spear-head shown in the specimens (Pl. II., fig. 6) is of bone—at least fish-bone—being the spine of the "cat-fish," a fish common in all the rivers of the district, and resembling an exaggerated "cobbler's thumb," with which those who are anglers have

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[5] *Melaleuca leucodendron.*

at times become painfully acquainted. The cat-fish has three spines—one dorsal and two pectoral—each about two inches long. The cat-fish of the Australian rivers is about sixteen inches long, and chiefly affects the bed of the river, as the unwary bather often discovers to his cost.[a]

These spears are generally used for taking fish, appropriately enough. The process is very simple. The native constructs a rude raft of logs, on which he ventures into a deep pool where fish are plenty. He has in one hand a piece of twine, to which is attached a bait, generally flesh, if procurable. The fish, attracted by this, comes up to nibble at it, and while its attention is engaged by the lure, the native promptly spears it.

These heads were broken off from shafts about ten feet long, formed of tolerably straight acacia stems—the "*Wattle*" (*Acacia mollissima*).

Two other interesting specimens were obtained at the same locality as the last. They are the front tooth of the small grey kangaroo, so common in Western Australia (Plate I., fig. 8). These were also probably used for fishing, as they appear to have been attached to the shafts of spears; but it is possible that they may have been used only as ornaments, such as are often worn by the head men, or medicine men of the tribe, usually attached to the beard.

We next come to the iron age, of which I have one representative, which has evidently been used as a spear-head. It is worked from a thin plate of iron, and evidently gave the worker more trouble than the flints he was accustomed to, for he has not had sufficient perseverance to bring it to a fine point.

I have another specimen of the iron age which appears to be a chisel, made also out of a thin plate of iron, apparently a piece of hoop iron.

I may mention that the natives are taking very kindly to iron as against flint. A knife or tomahawk left carelessly about when we had visitors in camp was sure to vanish. A suspected kleptomaniac in this respect—after whose visit we missed our best tomahawk—carried a neatly-constructed axe or tomahawk, fashioned out of a horse-shoe (new), picked up after our first journey. How he managed to cut that horse-shoe in half is a mystery to this day. The half horse-shoe, carefully sharpened and secured in the usual double handle, seemed to be a formidable weapon.

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[a] It will be noticed that these fish-spines have a double row of serrations.

MODE OF ATTACHING THE SPEAR-HEADS.

This is usually effected by means of the spinifer gum, which is obtained from the porcupine grass (*Triodia irritans*), a very annoying botanical product of North-western Australia. The "buck spinifer," from which this gum is obtained, covers vast areas of country, always marking a waterless district, as it flourishes on low rocks, or on their sandy soil, through which water rapidly disappears. It grows in a series of rounded tufts, composed of spines like exaggerated gorse thorns; sometimes 12 to 18 inches long, and is the terror of men and horses alike. It exudes a peculiar gummy substance; having an aromatic odour, which might be compared to that of a mixture of rice and honey, which, at first rather pleasant, becomes after a time—that is, when travelling through it—insupportably nauseous. The gum attaches itself to one's clothes and person, and is difficult to get rid of. From this material the natives make a very tenacious cement, which is easily manipulated by heating, and on hardening bears a great deal of rough usage. With few exceptions, all the weapons I have here this evening have been fastened on to their shafts or handles by means of this gum. It will be observed on the bases of the flint spear-heads, and also on the spear-shafts from Kimberley, which I exhibit, but from which the heads have been removed. In the case of the fishing spears, it is superseded or supplemented by the use of native bone.

I have here a lump of this cement found in a native camp. It is invariably a most important factor in a native kit; fragments of the spines of spinifer may be observed in it. As to the mode of manufacture, I am by no means certain, as the natives did not seem willing to give information. As far as I could learn, it is made by crushing the spinifer, and mixing the product with the red gum which exudes from one of the Eucalypts, and subjecting the mass to heat.

A similar gum is used by natives of the south for like purposes; but it is obtained from the "Grass tree" (*Xanthorrhœa*).

SPEARS: THEIR CHARACTER AND USES.

Before considering other stone implements, it is as well here to describe the general character of the spears used by the natives of Kimberley.

There are four species of spear used in Kimberley—

1. The war spear, called *Killawal*.
2. ,, large fishing spear, called *Mongwal*.
3. ,, small fishing spear, with fish-spine barbs, called *Mannifilea*.
4. ,, hunting spear, called *Mannifilea*.

1. The *Killawal* is used almost always in warfare. It consists of a thin shaft of some acacia, generally wattle, about 5 feet long, tipped with a finely-finished head of some kind of quartz, as before described. This primary shaft is inserted into a piece of bamboo, of about the same length, in which it is fastened by means of spinifer gum, supplemented with a tying of kangaroo sinew.

The idea is evidently to make the bamboo serve as the feather to the arrow. The light after-part in the same way preventing wobbling, on a principle that I should be sorry to try to explain in the presence of so many eminent mathematicians. I recollect well, however, as a boy, constructing cheap and effective arrows on the same principle, from light reeds, in the end of which a common nail was inserted, and which went straight to the mark, although not feathered.

These spears are always projected from the "throwing stick," called in Kimberley *Gnalealing;* in the north-western district, about Nicholl Bay, *Wommerah,* and in the south, *Meero.*

This method of throwing the war spear and some of the hunting spears is common throughout the Australian colonies.

The *Wommerah* varies greatly in size and shape, but the method of use is always the same. It is a flattish stick, with a hook at one end, which is inserted into a hole at the end of the spear. The *Wommerah* is held between the second and third fingers, and the spear between the first finger and thumb. The thrower, before discharging his weapon, quivers it in a remarkable manner while taking aim; and as he can generally send it through a man's body at from 30 to 50 yards, it was generally understood that when a native "shook his spear" at you, you were legally justified in anticipating his shot if you could.

The large *Mongwal,* or fishing spear, is chiefly used in hunting the small crocodile, which infests these rivers, generally not more than 6 or 8 feet long, and called by the natives *Nquana.* This spear is about 10 feet long, and about 1½ inch thick, made of a hard wood, sharpened at both ends, and then hardened by fire. The natives creep on the basking crocodile, and thrust the spear into the soft part beneath the forearm.

The *Mannifilea,* or fishing spear, has already been described. (Plate II., fig. 6.)

The light hunting spear, also called *Mannifilea,* is simply a straight "wattle," hardened by fire, and pointed at one end. It is about 8 feet long, and is used in slaughtering kangaroo, turkey (the Bustard), Emu, and other game.

Specimens from South-western Australia will give a good idea of the *Mannifilea;* but, unlike the latter, they are thrown from the throwing stick, called in this case *Meero.*

In the various districts of Western Australia the dialects are very distinct, and are so even in such a short distance as fifty miles. So that each tribe applies a very different name to the same weapon.

For instance, in the north the spears are called *Killawal;* in the Murchison and Gascoyne districts *Pillarra,* and in the south *Gid-jie.*

It is only in the north that flint is used as a spear-head proper; and this custom, I may say, extends across the whole of the northern portion of Australia generally.

But below from 20° to 30° south latitude wooden spears prevail. Among the many tribes it is the custom to insert rough chips of basalt or hard metamorphic rock, and in latter days, glass, along the edges of the spear-heads, but it is only the most northern tribes who tip their weapons with single flint-heads.

The *Pillarra* of the Murchison is a wooden spear of a formidable nature. The head is about 2 feet long, of triangular shape, like a bayonet, but on each edge has been carved a series of barbs, pointing backwards. If this weapon penetrates any part of a man's body, the only method of extraction is to push the spear-head right through.

But I have here a far more formidable instrument. It can be used either as a spear-head attached to a suitable shaft, or as a dagger. It is used by the natives of the Nichol Bay district, and is usually known as a punishing spear. It is about 18 inches long, and, besides being sharply pointed, is provided with six rows of double cleat-shaped points, carved on the circumference out of the solid wood, and extending in all for a length of 14 inches.

It is obvious that if this weapon is thrust into a body, there will be considerable difficulty in extracting it. You cannot push it forward, and you cannot pull it backward. I leave it to others to say what would be the right course to pursue under these circumstances; but I was credibly informed that natives punished with one of these instruments have survived, and succeeded in extracting the spear-head.

It is chiefly used as a punishment for heinous tribal offences, one of the chief of which is adultery. In most of these cases, if the injured husband catches the guilty parties, he is at liberty to spear his wife, which he generally does very promptly. The paramour is also very often speared to death, but this is not considered an essential

matter. All that wounded honour requires is that he should be speared in such place as the husband may elect; and the gay Lothario cheerfully holds out his leg while the bereaved widower, as he then is, drives one of these implements into the fleshy part of his thigh.

I cannot find the name of this terrible weapon amongst my notes.

In Victoria the spear is called *Mongile*. It varies considerably in shape in different districts, but is usually barbed either by cutting the wood itself or by inserting pieces of flint or basalt on the sides of the point.

The thrower, or *Wommerah*, has been already described. It is curious that the *Gnalealing* of Kimberley closely resembles the *Gurreek* of the *Yarra* tribe of Victoria in the extreme south, except in length; the latter being only about 2 feet long, while that of Kimberley is 3 feet 4½ inches long, and only 2 inches wide. (See Plate II., figs. 15, 15′.)

The next most important *offensive* weapon is that known popularly as the *Boomerang;* a name, however, that is utterly unknown either in Western Australia, South Australia, or Victoria. I am unable at present to fix its locality, if the word is at all in use in Australia.

In every district this weapon, although essentially the same, has a different appellation.

I have here two districts in West Australia represented.

In Kimberley, on the Fitzroy River, the title is *Jibber*, a word applied both to the hunting and war *Boomerang*.

In the Swan River district in the south the designation is *Kylie;* and this word is used by the whites throughout Western Australia, and largely by the blacks.

In Victoria the instrument is generally called *Wonguim;* but the title varies with different tribes, and according to different shapes. On the Murray River the name *Witto-ah-will* is given, while the Yarra natives have a but slightly different weapon, called *Baru-geek*, and called on the Murray *Braah-ba-witto-ah*. The last have a modification, used both as a sword and a missile, called *Quirrany-au-wun;* while in the Omus district a curious instrument, partaking of the nature of a sword, boomerang, and shield, is called the *Li-lil*.

All these weapons are supposed to be fashioned after the leaf of the white gum, which, like most other Eucalypts, has a curved sabre-like leaf, and gyrate as they fall. One thrown forward returns like the *Kylie*.

Some boomerangs, however, are made so that they do not return. These are hunting *Jibbers*, which are made for throwing straight forwards, and striking fish and birds.

The great amount of curve, measuring 5 to 6 inches, is noticeable. It will also be observed that they are built in a straight plane. (Plate II., figs. 1 and 1′.)

On the other hand, the war *Kylies* or *Jibbers*, which are returning ones, have a very perceptible twist, and the curve measurement is only 2½ to 3½ inches. (Plate II., fig. 2.)

The *Kylie* or *Jibber* is usually thrown with the point forward, and horizontally, a certain inclination being given to it as it is required to rise in the air, or the reverse.

Club.—Next in order comes the *Nowala* or *Ngowla* (Plate II., fig. 7), known as the *Dowak* in the south. This is used both as a shillelagh and a missile, being often known as the throwing-stick, and used in the fashion of "Aunt Sally" sticks, is generally a formidable weapon.

DEFENSIVE WEAPONS.

These are represented by shields, which are called *Carrbina* in the Kimberley language.

The *Carrbina* is 2 feet 5½ inches long, and only 4¾ inches wide. (See Plate II., fig. 3.) It is made, I think, from the Capput tree, and is ornamented in front by a series of vertical grooves, and on the reverse by a combination of vertical and zig-zag lines, forming a regular and elaborate pattern. This pattern is extremely interesting, showing, as it does, a marked resemblance to the chevron and diamond scrollings on some of our ancient Irish monuments. I shall refer to this later on; but may mention that this shield is for an Australian one somewhat unique, as it is not usual in the southern districts to have any markings on the back of the shield. With this slight defence, the natives can ward off spears and other missiles, although quickly and skilfully thrown. As a test, a native protected with one of these shields stood at a distance of twenty yards, while the manager of the Guda station threw with all his strength some twenty small pebbles, yet all were caught on the shield save one, which struck the native.

IMPLEMENTS NOT WEAPONS.

Stone Tomahawks.—Three of these, which are known in the Kimberley dialect as *Uahna*, are shown in Plate II., figs. 8, 12, 12′, 13, 13′, and their resemblance to Irish forms is very remarkable. They are usually formed of fine-grained basalt, rudely chipped, but worked to a fine edge. One specimen (fig. 13) is of hard grit, and exactly

resembles some of the stone celts obtained in the neighbourhood of Lough Neagh.

The manner of fastening these hatchets into the handle is extremely simple. The handle consists of a slip of acacia, bent round the stone head, which is fixed in its place by means of some "red gum" or "spinifer gum," while the two arms of the handle are fastened with a couple of thongs of kangaroo sinew.

Swinging Sticks used in the Rites of Initiation.

It is well known that in all the Australian tribes there are certain rites of initiation to be undergone by the boys who have reached the age of puberty. In the northern parts of West Australia, circumcision and allied rites are practised over a large district, and at certain times large numbers of a tribe assemble to take part in these ceremonies.

Boys of the age of about 10 years are subjected to certain very painful operations, the use or meaning of which have not yet been fully ascertained; and while these operations are being performed the men of the tribe who sit about swing around their heads flat sticks, such as figured in Plate II., figs. 4, 4′ and 5, 5′. These are about 16 inches long and 2 inches wide, and about 2¼ inches thick; and a number of these being wound round by perhaps 200 or 300 natives, create a booming sound, supposed to be intended to drown the cries of the sufferer.

These sticks are very jealously guarded, and I found it rather difficult to obtain specimens. They are always hidden away after the ceremony; the men do not like even to speak of them, and no woman is supposed even to know of their existence or use, or can she look on them except on pain of death.

In this case also the markings are peculiarly suggestive of our ancient Irish markings. (Plate III., figs. 1 and 2.) Mr. W. F. Wakeman, who has had great experience with regard to Irish scribings, remarked their almost exactitude. It is very remarkable, and I shall certainly not endeavour to account for it, that we should find in this collection of weapons, &c., from the Antipodes the well-known circles, channel markings, chevrons, and squares, so familiar to all as occurring on Irish monuments.

Stone Chisels (Plate I., figs. 9, 10, 11).—In these again we have an almost exact copy of the so-called thumb-stones or scrapers of the Irish flint period; but the Australian implement is used for the carving of wood, not for scraping skins, as it is supposed the Irish one

was intended for. These chisels were set into wooden handles by means of the spinifer gum, already mentioned, as used to attach spear-heads.

Figs. 10 and 11, Plate II., show bone implements, not unlike those found in ancient deposits at home. Fig. 9, Plate II., is part of a fire-stick converted into a bradawl by the insertion of a brass nail. This fire-stick is identical in form and mode of use with that at present made use of by the natives of the Nicobar Islands.

IX.

NOTES ON SOME HABITS AND CUSTOMS OF THE NATIVES OF THE KIMBERLEY DISTRICT, WESTERN AUSTRALIA.

By EDWARD T. HARDMAN, F.R.G.S.I., Her Majesty's Geological Survey; late Government Geologist, Western Australia.

[Read January 10, 1887.]

In the course of two visits to the northern part of Western Australia, of seven and nine months respectively, while engaged on a Geological Survey of the district, I had many opportunities of noticing the characteristics of the Aborigines. I was also able to obtain a small collection of native weapons and implements, some photographs, and four skulls. An account of the native weapons I have already submitted to this Academy.

The Kimberley district is the extreme northern portion of Western Australia, lying between 13° 50′ and 19° 30′ south latitude, and extending from longitude 122° east to 129° east, and is, therefore, well within the tropics.

The natives differ but little from the other tribes of the great Island Continent in appearance, except that they are generally—that is the males—tall and somewhat superior in physique. The average height of the men is 5 feet 8 inches, and the chest measurement is about 31 inches. But like all the Australian races they are deficient in the legs, which are very thin, as will be noticed in the photographs. Their average weight is much below that of white men. For instance one man who stood 6 feet 2 inches, and whose native name was, by a curious coincidence, "Lofty," weighed but 9 stones—126 lbs.

The development of these men seems to take place altogether in the torso, and I have seen many men so powerfully built, as to chest and arms, that it seemed difficult to realize how such poor spindle-shanked legs could support the body. This is the more curious, seeing that their nomadic tribes travel on foot, and one might suppose that the leg muscles would be largely developed.

Yet, though so attenuated in the lower limbs, they are wiry and vigorous. I have known these natives to trot fifteen or twenty miles alongside of our cavalcade on the chance of getting a little damper and sugar when we camped down.

The women rarely exceed 5 feet in height, seldom, indeed, reaching that altitude. The young girls, although not by any means to be called handsome, or even pretty, have often a pleasing and lively expression of countenance; but the older women are not only ugly, but sometimes positively repulsive-looking. Indeed I recollect one of our surveyors actually lost his appetite, for a day, after casually meeting one of these old dames.

The photographs I exhibit will convey a fair idea as to the average appearance of this race.

Polygamy is an institution, and the number of wives is chiefly restricted by the man's taste for matrimony, his means of supporting a large family, and his interest with those of his friends who have female children to give away.

As a rule, the females are monopolized by the older and more influential men of the tribe. It is in fact rare to find a married man, or, as they term it in pigeon English, "oolman" under 30 or 40 years of age.

The young men are eligible for marriage after twelve months from the time when they have been "welgied"—that is, painted with red ochre—which is done when they are about eighteen years old, and they are then known as *Bielbuhr*. But *Bielbuhr*, corresponding to our *bachelor*, but with perhaps more moral restrictions, they remain, until they obtain a wife from the tribe, or manage to steal one from another community. After marriage, the man is called *Dalübrr*.

Very often the new-born female children are "sealed" to some influential man, usually an old man, of the tribe; and during the intervening time, until marriage, usually ten years, the man cannot even look upon his bethrothed; nor is he allowed to hold any intercourse with, or even to see, his future mother-in-law, this last rule being continued for some time after the marriage.

Indeed it is said that in some tribes the rule is strictly enforced even after marriage. If the man sees his mother-in-law he is bound to avoid her, and *vice versâ*. Whether this rule was instituted for the better preservation of the peace in families, I know not.

MARRIAGE LAWS.

These are very peculiar, but are only modifications of those existing amongst all Australian tribes. It has been thought that they have been devised to prevent, to some degree, consanguineous marriages; but the true reason, as will be seen in the sequel,

appears to be to render incest impossible. The marriage laws of many of the islands in the Malay Archipelago have the same tendency.

There are in the Kimberley district four marriage sects, or families, viz.:—Paljari, Kimera, Boorungoo, and Bannighu.

Now, a Paljari cannot marry a Paljari, nor a Kimera a Kimera. I should mention that the four sects exist in each tribe; but the following is the rule:—

MAN.	WOMAN.	CHILDREN.	GRANDCHILDREN.
Paljari marries ..	Kimera.	Bannighu.	Paljari or Kimera.
Kimera ,, ..	Paljari.	Booroongoo.	
Bannighu ,, ..	Booroongoo.	Paljari.	Bannighu. or Booroongoo.
Booroongoo ,, ..	Bannighu.	Kimera.	

It will be observed that there is in each generation a constant change of marriage sects, and as these sects are altered according to male or female tribal marriages, the ultimate relations of members of the same tribe are very difficult to make out.

For instance, if a Paljari man marries a Kimera woman, the issue is *Bannighu;* but if a Kimera man marries a Paljari woman, the offspring is *Booroongoo.*

One thing is certain, on analyzing the above Table, that although cousins may in some cases intermarry, it would be impossible for a man to marry his sister or his daughter, although he might marry his granddaughter, an event hardly likely to occur.

These curious marriage laws—evidently intended to prevent incestuous intercourse—are general throughout the Australian Continent[1] as well as in the Malay Archipelago.

The extraordinary resemblance which this general law of these savage tribes bears to that laid down in Leviticus xx. is very striking. And while I am on this subject, I may mention another curious coin-

[1] See Brough Smith; *Aborigines of Victoria;* also A. W. Howitt: "Notes on Australian Class System."—*Journal Anthropological Society,* Vol. XII., No. iv., p. 497.

cidence with the Levitical law, and that is, that during the period of menstruation the females isolate themselves for a week, and for that time carefully avoid the most casual meeting with men.

I could not ascertain that any special ceremonies take place at the marriages of these people.

INITIATION RITES.

Next to the Marriage Laws in interest come the initiatory rites for the young boys and men. These are very remarkable, and so far as I can learn, they are more severe than any practised by other native Australians. They are chiefly confined to the males, but in some districts the young females are also subjected to painful operations.

The young boy, known colonially as a "crawler," is called "Yadup" till he is five years of age. He then becomes a "Chookadoo," and usually is given as a boy-wife to one of the young men. At about ten years of age the initiatory rites commence. The first is circumcision—an operation performed with a fragment of shell, or a piece of sharp flint—and at the same period the two upper front teeth are knocked out. He is now known as *Balillie*. A year later an operation is performed which produces an artificial *Hypospadias:* that is, the urethra is slit from the glans penis to the scrotum, and the edges of the cut are prevented from healing by the insertion of a flat piece of stone. The mode of performing this operation was thus described to me; it always takes place at a grand Corroboree :—

A shallow trench is dug, into which the boy is flung. One man lies across his chest, another across his legs, and then the "Bullia" man or Medicine man operates very leisurely with a piece of shell or with a sharp flint. In the meantime the women have been removed to a distance—they are supposed to know nothing of these ceremonies—and the men sitting around make a loud and confused noise—some by clapping their hands on their thighs, others by whirling rapidly the *mero-mero,* a thin flat stick, which, thus used, creates a heavy booming sound. These whirling-sticks, used to drown the shrieks of the victim, as well as the flint or shell-knives used in the operation, are considered sacred, and are not to be looked upon by women under pain of death.

It seems by no means certain what the meaning of this operation is. The natives are very reticent about it, and either pretend to be, or are really unable, to explain it. Two theories have been mooted—one that it is the outcome of Malthusian ideas; but this can hardly be, because

every boy is so treated, and the married men have no lack of families. On the other hand, it is supposed to have originated in a case of stricture, caused by drinking salt or brackish water; and an afflicted native having in desperation operated on himself, and obtaining relief, the practice was generally adopted. I think, however, it is simply some ancient rite connected with Phallic worship.

The boy is now a "Wongalong," and after a short interval he undergoes the process of having his body ornamented by various cuts and incisions on the shoulder blades, arms, chest, loins, and buttocks. These cuts are treated in such a manner that they form cicatrices often as thick as a man's finger, and raised like cords on the body. The natives are excessively proud of these markings, and endure severe tortures in order to develop them to the utmost.

In some tribes there is practised about this time the bleeding of the neophyte. An incision is made in the arm, and the elders suck the blood until the patient is well-nigh exhausted.

The next step is the *Wilgieing*. This is done when the young man is considered to have reached a marriageable age. In fact it signifies that he has come of age and has entered into his property. If he is betrothed, or can find a girl in the tribe, he can now marry.

"Wilgie" is a coarse red ochre, sometimes obtained from the river alluvials, and often made by burning the highly ferruginous sandstones of the district.

In the event of a wife not being obtainable, the youth is presented with a boy-wife, known as *Chookadoo*. In this case also the rules of the marriage sects are observed, and the husband is not permitted to have any intercourse with his *quasi* mother-in-law.

As before mentioned, the "Chookadoo" is a boy of five years to about ten, when he is initiated; but the relations which exist between him and his protecting *Billalu* are somewhat doubtful. There is no doubt they have connexion, but the natives repudiate with horror and disgust the idea of Sodomy.

The females are "Yadup" to five years; "Kunyerry" when they are cicatrized on the arms and shoulders, and have one or two front teeth knocked out. They are then "Uarrbun" up to the age of puberty. After marriage, and the birth of the first child, they are styled "Doobhjarndoo."[2]

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[2] The nasal septum is pierced in the male, and sometimes ornamented with a piece of horn or bamboo; but I only noticed this once in the case of a woman.

PUNISHMENT OF ADULTERY.

On the whole, these natives are by no means of such a low type of humanity as has been supposed. They are quick and intelligent, easily taught, and become tractable and willing servants. Their talent for languages usually surpasses that of the white man ; they possess musical instruments, and, as is exemplified in the carving of their weapons and implements, and in the drawings which may be often seen in cairns and on rocks, have some notions of art.

In the southern district, the natives at the Mission of New Norcia have been trained by Bishop Salvado to not only sing in the choir, but to accompany the chanting with a full string and wood band, and the performance is far from contemptible.

The author concluded with some remarks on the burial customs, and exhibited four skulls of Kimberley natives, brought home by him, which had been measured and described by Dr. Phin. S. Abraham.

N.B.—Owing to the decease of Mr. Hardman before these Papers were printed, they have not had the benefit of his revision.—[EDITOR.]

X.

NOTES ON WORKED FLINTS FOUND ON A RAISED BEACH AT PORTRUSH IN AUGUST, 1886. By W. J. SIMPSON, Belfast.

[Read January 24, 1887.]

The accompanying specimens of worked flints were found at Portrush, county Antrim, in the centre of the town, and in the immediate vicinity of an ancient beach which had been exposed to view, through the removal for building and other purposes of a vast quantity of sand, which covered it to the extent of thirty, and in some places fully forty feet.

The first discovery of flints at this place was made at the latter end of July (1886) by a working man named Gallagher, who disposed of his specimens to a few residents in the neighbourhood who took an interest in the matter. I visited the place on August 2nd, 1886, and found that on the removal of the accumulation of sand (which was the result of years of labour), the ancient beach could be traced distinctly. Water-worn boulders, pebbles and flints, of the usual types, all bearing unmistakeable traces of the action of water, became visible. Underneath the sand in which these remains were embedded, and which was quite different in appearance from the more recent accumulation (beneath which all had been buried, and which, as I have before stated, had been gradually removed), at a depth, varying according to the nature of the ground, of from 5 to 10 feet, I found a layer of peaty soil, consisting of sand and decayed vegetable matter, the appearance and composition of which was quite different from the superincumbent layer, which formed the ancient beach. It was of a dark-brown colour, varying to black, and would convey the impression that it consisted of decayed moss, mixed with sand and clay. In this deposit the worked flints were found in such quantities, that it was scarcely possible to turn up a spadeful of the soil without finding half a dozen. This peaty soil, I have been informed by men who have laboured in removing the sand, etc., extends to a depth of about 8 feet. When water was upon the *beach*, the place where the flints were found must have been covered to a certain depth; then the question arises, Was it submerged prior to the advent of the flint-workers? I should conclude that the water had receded, and that vegetation, such as may

be observed on the adjacent sand-hills, was in progress at the period to which I refer. Flint cores and large nodules are plentiful; the worked pieces vary in size from minute fragments, about $\frac{3}{16}$th of an inch in length, to $1\frac{1}{2}$ and 2 inches: they are rudely fashioned. Scrapers of various lengths, and peculiar sharpened bent pieces, have also been discovered.

I occasionally came upon charred substances, which crumbled away upon removal, and pottery fragments here and there, but I found none worth removing. The exact locality where the flints were discovered is situated on the south side of the road leading to Dunluce, in the immediate vicinity of a row of small houses, called "Springhill." I enclose photograph of the place, looking westward. I have been informed by some of the inhabitants of the place that the removal of the sand has been going on for the past twelve years; it covered to the extent of thirty, and in some places fully forty feet, the soil in which the worked flints were found, which is at least forty feet above present sea level. I made several attempts in other localities where sand had been removed, but was unable to find any flints which bore traces of working. With regard to the peaty soil to which I refer, on the western shore, towards Portstewart, before coming to the basalt, it may be observed in perfection, forming great slabs, partially covered by sand, and in other places showing distinctly in the sides of the sand-hills which border the shore. At various points along the coast I examined carefully this vegetable substance, but could not find any trace whatever of flints; but I found the peaty soil so compressed, that it had almost become turf; the vegetable substances, of which it is so largely composed, had become totally decayed, and thoroughly amalgamated with the sand, to such an extent that it cut just like a piece of soap, which it resembled in consistency. The fragments of pottery were not embedded in the peaty soil to any depth, but were found upon the top. I found many of the flints lying on the surface when the more recent accumulation of sand was carefully removed, but upon digging they became more plentiful.

XI.

THE PERONEUS QUINTI DIGITI. By D. J. CUNNINGHAM (M.D. Edin. et Dubl.), Professor of Anatomy, Trinity College; and H. St. JOHN BROOKS, M. D., Dubl., Demonstrator of Anatomy, Trinity College, Dublin.

[Read June 27, 1887.]

This communication was suggested to us by the occurrence of two remarkably well-developed examples of the peroneus quinti digiti muscle in the Dissecting-room of Trinity College. The tendinous slip which bears this name is only occasionally present in the human foot. It is of little or no functional value; but it possesses a high interest in connexion with the history of the peroneus brevis and extensor brevis digitorum muscles. In its most common condition this slender tendinous slip springs from the tendon of the peroneus brevis on the outer side of the foot, and proceeds forwards to the dorsum of the little toe, where it lies in series with the four tendons which the extensor brevis digitorum gives to the four inner toes.

A few years ago Dr. George Ruge[1] of Heidelberg proved in the most conclusive manner that the position of the extensor brevis on the dorsum of the foot is not primitive, but one which is acquired. Originally it was a muscle of the leg, and arose from the fibula along with the peroneal muscles. In the ornithorhynchus it consists of two parts—(1) an extensor brevis of the four inner toes, to each of which it sends a tendon; (2) an extensor brevis of the little toe. But further, the peroneus brevis can hardly be said to have any existence in this condition. It is merely represented by a small tendinous slip which proceeds from the tendon of the extensor brevis of the little toe. From this and other facts Ruge comes to the conclusion that the peroneus brevis is to be regarded as an offshoot from the extensor brevis V.

In the animal groups which intervene between the ornithorhynchus

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[1] Untersuchung über die Extensorengruppe am Unterschenkel und Fusse der Säugethiere.—*Morph. Jahr.*, 1880.

and man the descent of the extensor brevis I.-IV. can be traced step by step. First one belly descends, and then another, and so on until all the four tendons spring from fleshy bellies which lie on the dorsum of the foot. But what becomes of the extensor brevis V.? It is left behind. A peroneus brevis is developed out of it, and ultimately in the higher forms, as in man, the offspring swallows up the parent; in other words, the extensor brevis V. is obliterated, and only occasionally appears in the form of the little tendinous slip which receives the name of the *peroneus quinti digiti.*

With a history so interesting it is not surprising that the peroneus quinti digiti (or extensor brevis V.) should have received so much attention from anatomists—an attention which, as we have already stated, is altogether unwarranted by its functional importance. Statistics of its relative frequency have been given by Pozzi[2] and Wood.[3] The former anatomist examined 28 subjects, and found the muscle present in four cases, *i. e.* 1 in 7. Wood has published two series of statistics. In the first of these he only met with the peroneus quinti digiti five times in 32 subjects; but in his later, and more complete statistics, he states that he discovered it 36 times in 102 subjects, *i. e.* 1 in 3.

For two years we have kept an accurate record of the occurence of the peroneus quinti digiti in the Practical Anatomy Department of Trinity College. Forty-five lower limbs were specially examined, with a view of determining whether it was present or not. The following are our results:—

Present in a well-marked form in	21	cases.
,, ,, rudimentary form in	5	,,
Absent in	19	,,
	45	

In the cases indicated as "present in a well-marked form," the tendinous slip arose from the tendon of the peroneus brevis at some point between the maleolus and the projection on the base of the fifth metatarsal bone, and joined the dorsal expansion of the long extensor tendon of the little toe. In those cases indicated as "rudimentary"

[2] *Journ. de l'Anatomie et de la Phys.*, 1872.

[3] *Proc. Roy. Soc. Lond.*, vols. xv. and xvi.

the tendinous slip was lost on the dorsum of the fifth metatarsal bone and the fascia which covers the fourth dorsal interosseous muscle.

There cannot be a doubt that Pozzi, and also Wood in his first statistics, altogether understate the frequency of occurrence of the peroneus quinti digiti in man. Testut expresses a similar view in his remarkable work, entitled 'Les Anomalies musculaires chez homme.'' He says with reference to the results obtained by these authors: "Ce rapport est bien évidemment trop faible, si l'on tient compte de tous les cas où un tendon surnuméraire se detache du tendon du court péronier latéral pour se terminer sur n'importe quel point de la région tarso-métarsienne."

The more recent statistics of Wood more nearly express the truth, and in these he distinctly records all forms of the muscle, both rudimentary and well-developed; still they fall considerably short of the results obtained by us. Perhaps an average struck from both would yield the most accurate result. This would give 60 cases in which it was present out of 147, *i. e.* 40 per cent.

But the peroneus quinti digiti is not always found in this very rudimentary condition. In the forty-five subjects examined it was observed on two occasions to be provided with a fleshy belly. In one instance this fleshy belly was only partially blended with the peroneus brevis. It arose in the leg from the septum which intervenes between the peroneal group of muscles and the muscles on the posterior aspect of the leg, and its tendon turned round the external maleolus in the peroneal sheath, and finally found insertion into the tendon of the common extensor which goes to the little toe. Such a condition is not unknown. Macalister[4] has also described such a muscle. Here, then, is an example of the extensor brevis minimi digiti reverting to its original separate condition, and asserting its primitive independence.

In the second case the muscle arose by a tendionous slip from the tendon of the peroneus brevis as it turned round the external maleolus. This gave place to a fusiform fleshy belly which was situated on the dorsum of the foot, on the outer side of the extensor brevis digitorum, and closely connected with it by areolar tissue. It finally ended in a slender tendon, which presented the usual insertion on the dorsum of the little toe. Similar cases have been recorded by Hallet,[5] Wood,[6]

[4] "Muscular Anomalies in Human Anatomy"—*Trans. Roy. Irish Acad.*, vol. xxv. (Science), p. 133.

[5] Hallet, *Edin. Med. and Surg. Journ.*, 1848.

[6] Wood, *Proc. Roy. Soc.*, vol. xvi.

Macalister,[7] and Testut,[8] and they indicate a tendency on the part of this muscle, not only to separate itself from the peroneus brevis, but to descend to the foot for its origin, and range itself alongside its former companion, the extensor brevis I.-IV.

From what has been said, it will be seen that the peroneus quinti digiti offers a very striking example of atavism, or reversion to a former type.

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[7] Macalister, *Proc. Roy. Irish Acad.*, vol. i., 2nd series. Science.

[8] Testut, *Les Anomalies musculaires chez l'homme.*

XII.

GEOMETRICAL ILLUSTRATIONS OF NEWLANDS' AND MENDELEJEFF'S PERIODIC LAW OF THE ATOMIC WEIGHTS OF THE CHEMICAL ELEMENTS. By REV. SAMUEL HAUGHTON, M.D. (Plates IV.–VIII.)

[**Abstract.**]

PART I.—THE FIRST AND SECOND PERIODS OF SEVEN ELEMENTS FOLLOWING HYDROGEN; OR, *THE CARBON-SILICON DOUBLE PERIOD.*

[Read April 28, 1888.]

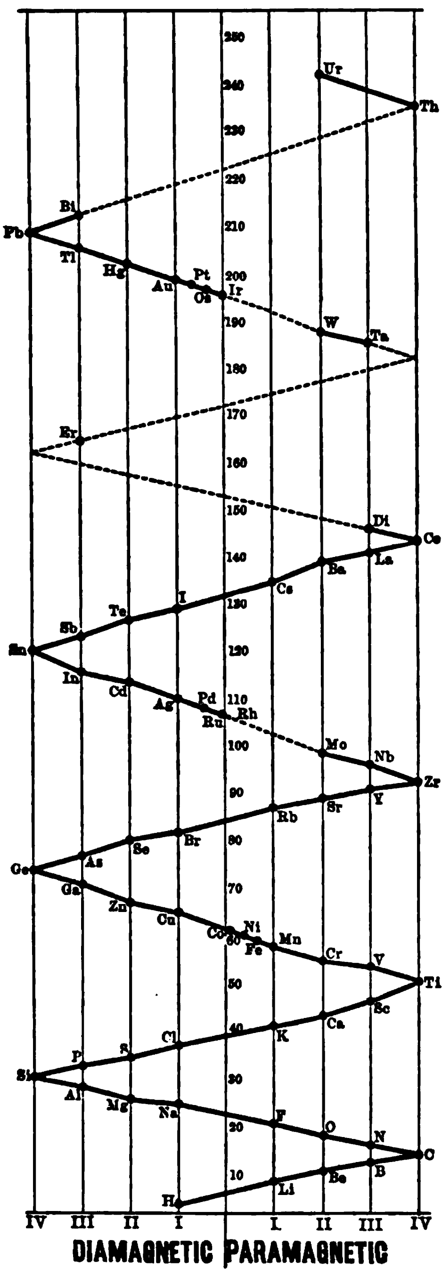
I assume on the part of my readers a general knowledge of Newlands' *Law of Octaves*, of Mendelejeff's *Periodic Law*, and of Reynolds' graphic representation of the results arrived at by their successors on this remarkable subject.

I reproduce, in Plate IV., with Dr. Reynolds' permission, the most recent graphic representation of the Periodic Law.

In this diagram the elements are plotted according to their atomic weights and valencies; the vertical co-ordinates being atomic weights, and the horizontal co-ordinates being valencies, counted (for convenience of plotting) positive or negative, according as the element belongs to an odd or even period of seven.

First Period, or Carbon Period.

ELEMENT.	ATOMIC WEIGHT.	VALENCY.
1. Lithium.	7	Monad.
2. Beryllium.	9	Dyad.
3. Boron.	11	Triad.
4. Carbon.	12	Tetrad.
5. Nitrogen.	14	Triad.
6. Oxygen.	16	Dyad.
7. Fluorine.	19	Monad.


Ur
Th
Bi
Pb
Tl
Hg
Au
Pt
Os
Ir
W
Ta
Er
Di
Ce
La
Ba
Cs
I
Te
Sb
Sn
In
Cd
Ag
Pd
Ru
Rh
Mo
Nb
Zr
Y
Sr
Rb
Br
Se
As
Ge
Ga
Zn
Cu
Co
Ni
Fe
Mn
Cr
V
Ti
Sc
Ca
K
Cl
S
P
Si
Al
Mg
Na
F
O
N
C
B
Be
Li
H
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
IV III II I I II III IV
DIAMAGNETIC PARAMAGNETIC

Second Period, or Silicon Period.

ELEMENT.	ATOMIC WEIGHT.	VALENCY.
1. Sodium.	23	Monad.
2. Magnesium.	24	Dyad.
3. Aluminium.	27	Triad.
4. Silicon.	28	Tetrad.
5. Phosphorus.	31	Triad.
6. Sulphur.	32	Dyad.
7. Chlorine.	35½	Monad.

In Plate v. I show, on an enlarged scale, Dr. Reynolds' diagram for the above-named Carbon and Silicon Periods, following hydrogen. This diagram is formed by joining together by right lines the successive fourteen points, commencing with lithium and ending with chlorine. If the points were at random, the number of right lines would be thirteen; and this would be the order of the curve passing through the fourteen points, and an infinite number of such curves could be drawn, and the problem would be geometrically indefinite. The points being supposed placed at random, it is well known that a single general quartic curve can be drawn through them, and one only, thus giving an unique geometrical solution.

A general quartic curve is therefore the simplest solution that the collocation of fourteen points admits of in its most difficult form; but this solution may become simpler, if the points are arranged by a law or method, and not at random.

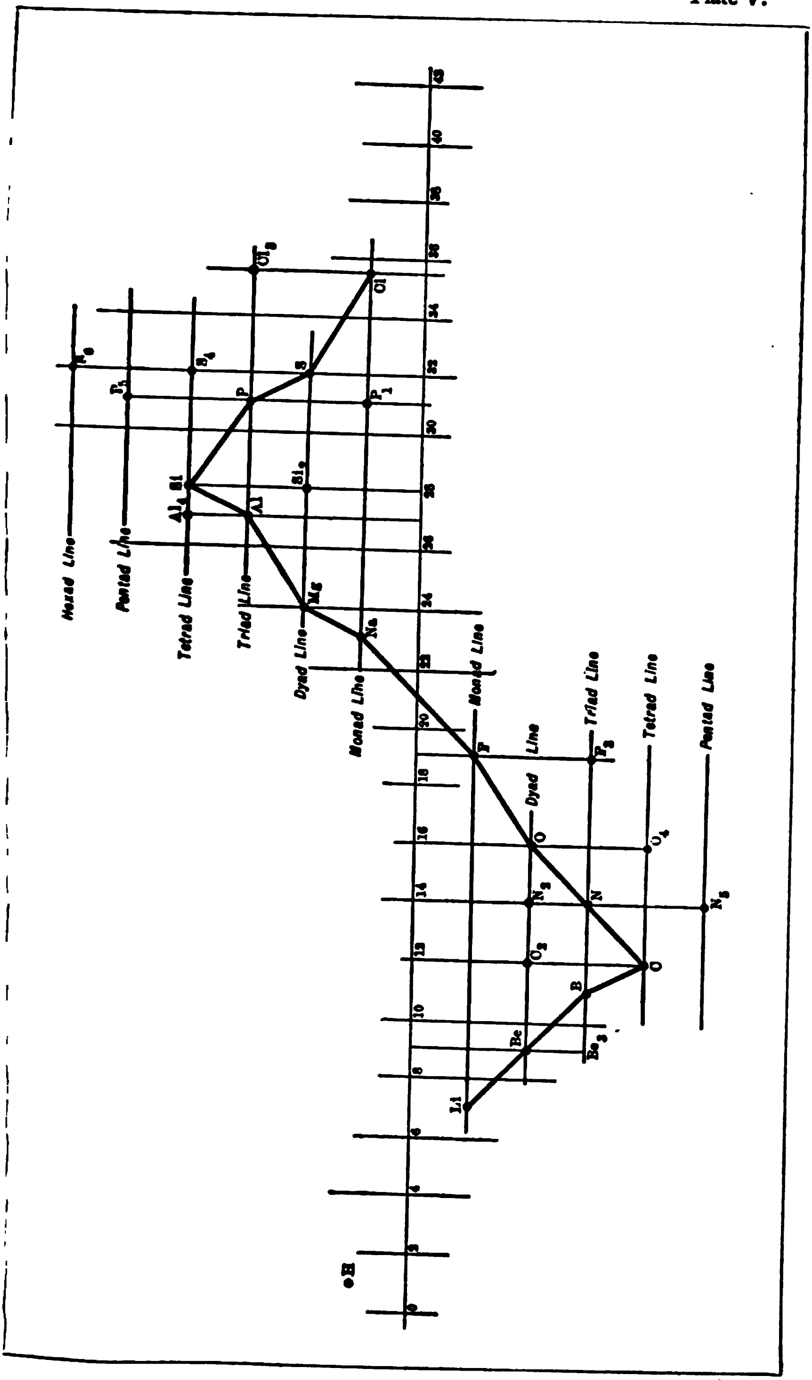
In the problem now before us, we find on inspection that five of the fourteen points lie on the same straight line,[1] viz.:—

C | N | O | Mg | Si.

This is shown in Plate vi.

This line joins the two tedrads, carbon and silicon, and passes through the point 20 of the line of atomic weights.

[1] The chances are millions to one against this happening at random.


Hexad Line
Pentad Line
Tetrad Line
Triad Line
Dyad Line
Monad Line
Monad Line
Dyad Line
Triad Line
Tetrad Line
Pentad Line

There remain nine points not accounted for, viz.:—

Li | Be | B | F | Na | Al | P | S | Cl.

These nine points are found to lie upon a simple serpentine cubic with one real asymptote, which I have plotted in Plate VI.

Taking the point 20 for origin, the co-ordinates of the nine points are as follows:—

	x	y
1. Lithium.	− 13	− 1
2. Beryllium.	− 11	− 2
3. Boron.	− 9	− 3
4. Fluorine.	− 1	− 1
5. Sodium.	+ 3	+ 1
6. Aluminium.	+ 7	+ 3
7. Phosphorus.	+ 11	+ 3
8. Sulphur.	+ 12	+ 2
9. Chlorine.	+ 15½	+ 1

By means of this Table, the nine unknown co-efficients of the cubic can be found, and the curve plotted, with its asymptote, as I have done in Plate VI.

The total curve consists of—

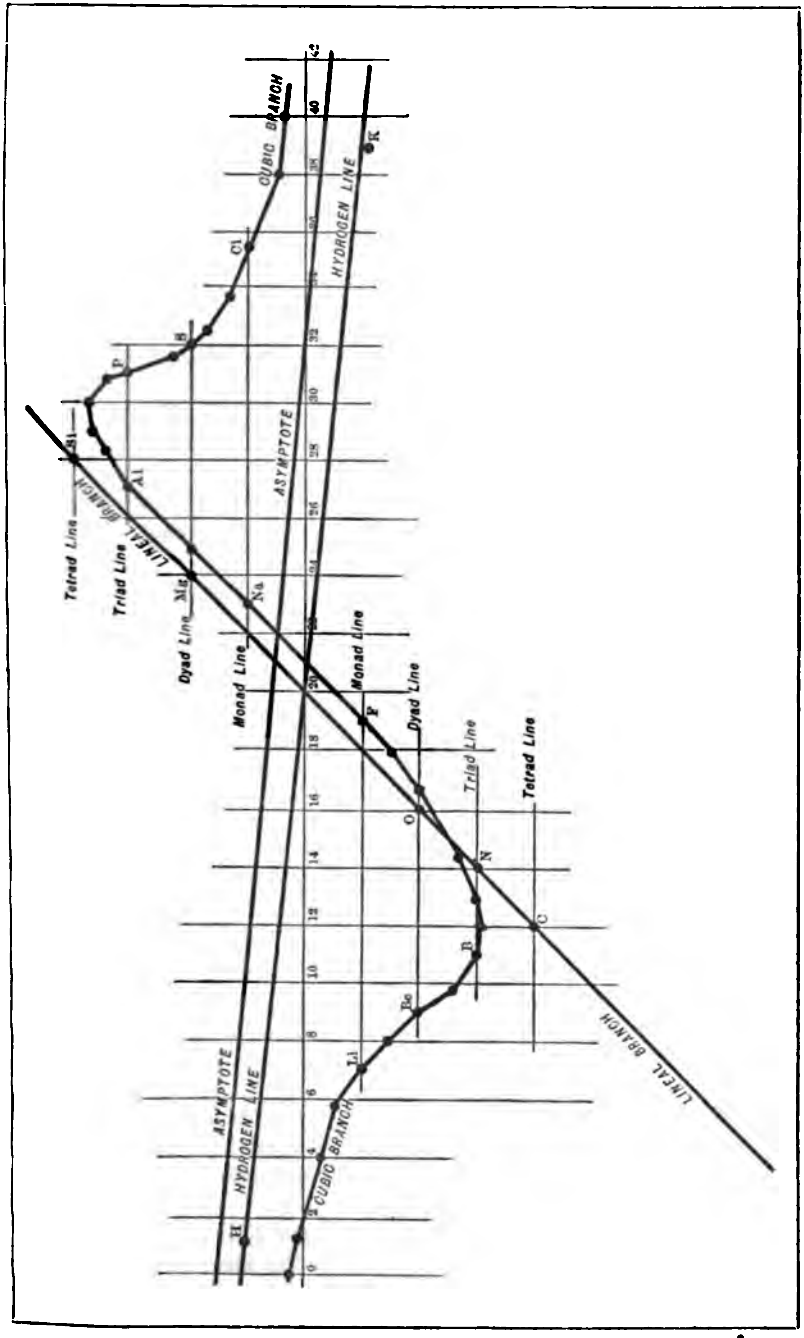
a. the lineal branch;

b. the cubic branch;

and there is a possibility of forming an element wherever the monad, dyad, triad, or tetrad lines intersect the curve.

The first three elements, viz.—Li | Be | B group themselves upon the cubic branch, and also the last three elements, viz. P | S | Cl are found upon the cubic branch.

The fourth element, carbon, is found upon the lineal branch, and could not occur upon the cubic branch, which lies altogether inside the


CUBIC BRANCH
HYDROGEN LINE
ASYMPTOTE
LINEAL BRANCH
Tetrad Line
Triad Line
Dyad Line
Monad Line
Monad Line
Dyad Line
Triad Line
Tetrad Line
LINEAL BRANCH
ASYMPTOTE
HYDROGEN LINE
CUBIC BRANCH
K
Cl
S
P
Si
Al
Mg
Na
F
O
N
C
B
Be
Li
H
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42

tetrad line, and the same remark applies to the eleventh element, silicon.

In the remaining six elements lying between carbon and silicon, what (for want of a better word) I may call a "contest" takes place between the lineal branch and the cubic branch as to which of them shall have the element, but in no case are two elements formed with the same valency.

1. In the triad line, nitrogen is formed on the lineal branch, but there is distinctly intimated the possibility of another element on the cubic branch, with the atomic weight 13, where the cubic having passed through boron, again intersects the triad line.

2. On the dyad line, oxygen is formed on the lineal branch, but the possibility is shown of another element on the cubic branch, with the atomic weight 16·4.

3. On the monad line, fluorine is formed on the cubic branch, with a possibility of another element on the lineal branch, of atomic weight 18.

4. Again, sodium is formed on the cubic branch, with a possibility of an element on the lineal branch, with atomic weight 22.

5. Magnesium is formed on the lineal branch, with a possibility of another element on the cubic branch, with atomic weight 25.

And, lastly, aluminium appears on the cubic branch, with a possibility of another element on the lineal branch, of atomic weight 26.

These two periods of seven elements each form the first two octaves of the chemical harmony of the universe; but what are we to do with hydrogen, which remains alone, outside the harmony?

Mendelejeff thought that his six missing brothers and sisters were to be sought between hydrogen and lithium; but Dr. Reynolds easily proved that they must be sought for behind hydrogen, which is the last note of the primeval octave. Are they to be found between zero and unity, or looked for "behind the looking-glass" in the unknown land of negative atomicities, where heat, light, and electricity reside?

However this may be, I think it useful to point out a remarkable relation between hydrogen and the fourteen elements which follow it in atomic weight.

If we take the common centre of gravity of the fourteen elements (regarded as equal weights), and join this point with the point representing hydrogen, the line so found is very nearly parallel to the asymptote of the cubic curve drawn in Plate VI.

The difference in direction between the two lines is only 20′ arc.

Hydrogen, the first born, and king of the elements, sits alone,

without brothers or sisters, and seems to resemble the fabled Isis of Egyptian mythology—

Ἐγώ εἰμι πᾶν τὸ γεγονός, καὶ ὄν, και 'εσόμενον, καὶ τὸν ἐμὸν πέπλον οὐδείς πω θνητὸς ἀπεκάλυψε.

NOTE.

TABLE OF *Fifteen Elements, with Name of Discoverer and Date.*

ELEMENT.	NAME.	DATE.
1. Hydrogen.	Cavendish.	1781
2. Lithium.	Arfwedson.	1817
3. Beryllium.	Wohler.	1828
4. Boron.	Gay Lussac and Thenard.	1808
5. Carbon.	——	Prehistoric.
6. Nitrogen.	Rutherford.	1772
7. Oxygen.	Priestly.	1774
8. Fluorine.	Moissan.	1886
9. Sodium.	Davy.	1807
10. Magnesium.	Davy.	1808
11. Aluminium.	Wohler.	1828
12. Silicon.	Berzelius.	1823
13. Phosphorus.	Brandt.	1669
14. Sulphur.	——	Prehistoric.
15. Chlorine.	Scheele.	1774

PART II.—THE THIRD AND FOURTH PERIODS OF SEVEN ELEMENTS FOLLOWING CHLORINE; OR, *THE TITANIUM-GERMANIUM DOUBLE PERIOD.*

[Read May 14, 1888.]

I now proceed to the discussion of the third and fourth periods of seven elements each.

Third Period, or Titanium Period.

ELEMENT.	ATOMIC WEIGHT.	VALENCY.
1. Potassium.	39	Monad.
2. Calcium.	40	Dyad.
3. Scandium.[1]	44–45	Triad.
4. Titanium.	48	Tetrad.
5. Vanadium.	51	Triad.
6. Chromium.	52	Dyad.
7. Manganese.	55	Monad.

Fourth Period, or Germanium Period.

ELEMENT.	ATOMIC WEIGHT.	VALENCY.
1. Copper.	63	Monad.
2. Zinc.	65	Dyad.
3. Gallium (*Ekaluminium*).	69	Triad.
4. Germanium (*Eka Silicium*).	72	Tetrad.
5. Arsenic.	75	Triad.
6. Selenium.	79	Dyad.
7. Bromine.	80	Monad.

[1] The atomic weight of scandium lies between 44 and 45, but nearer to 44.

At the commencement of the year 1875 there were three unknown elements of this Table, viz.:—

Gallium, found in 1875;

Scandium, found in 1879;

Germanium, found in 1886.

And it is the glory of the Periodic Law of Modern Chemistry that it predicted (approximately) the atomic weights of these three unknown elements and their valencies, which predictions were fulfilled by the successive discovery of the unknown elements.

In Plate VII., which is a representation of the third and fourth periods of Dr. Reynolds' curve, we can see that a triad element is wanting between calcium and titanium, and both a triad and tetrad element wanting between zinc and arsenic. These missing elements were predicted and found.

It is quite true that there were three well-known elements lying between manganese and copper, viz. iron, nickel, and cobalt; but these three elements did not conform to the rules of the Periodic Law, and their places have been taken in that law by scandium, gallium, and germanium.

They were like the "three children in the oven" described by Daniel (Shadrach, Meshach, and Abednego), who refused to worship the Golden Image or Periodic Law set up by Nebuchadnezzar and the modern chemists.

I hope to show in the present Paper that iron, nickel, and cobalt are not so refractory as they appear at first sight; but, on the contrary, ready to take their proper places on the chemical curve when rightly interpreted.

An inspection of Plate VII. shows (just as we found in the former curve in the case of the tetrad elements, carbon and silicon) that the line joining the tetrad elements, titanium and germanium, contains five elements, viz.:

Ti | Va | Ca | Ga | Ge,

leaving nine elements free, which sit upon a general cubic—

K | Ca | Sc | Cr | Mn | Zn | As | Se | Br.

If we use the atomic weights and valencies of these nine elements (taking scandium = 44·3), we can find the equation of the cubic passing through these points, the form of which I have plotted in Plate VIII., and which has one real asymptote like the former cubic, but has a much more complex shape.[1] The dyad lines, both positive and negative, have a remarkable relation to the cubic curve. They are both very near the position of the horizontal tangent.

In fact, the positive dyad line intersects the cubic in three real points, viz.:—

79, 65·064, 65.

The first of these is the element selenium, and the third the element zinc, with another element almost identical with zinc in atomic weight, both points being nearly on the horizontal tangent.

The negative dyad line intersects the cubic in three real points also, viz.:—

40, 52, 56;

which represent exactly the atomic weights of the three elements—calcium, chromium, and iron.

Now, we must remember that the cubic curve was constructed without any reference to iron, or its atomic weight, and it is very remarkable to find it taking its place on the curve after chromium, and near nickel and cobalt, which are not far off the dyad line.

In fact, the cubic curve points out, by clinging to the dyad line, from 52 to 59, the possibility of forming, in that interval, a number of elements similar to each other in physical and chemical properties. These elements have been actually formed, and are—

Chromium, Iron, Nickel, Cobalt.

Excepting these four elements formed on the cubic branch of the curve, the distribution of the remaining elements, between the lineal and cubic branches, is similar to that found in the curve described in Part I.

The first three elements are on the cubic, viz.—

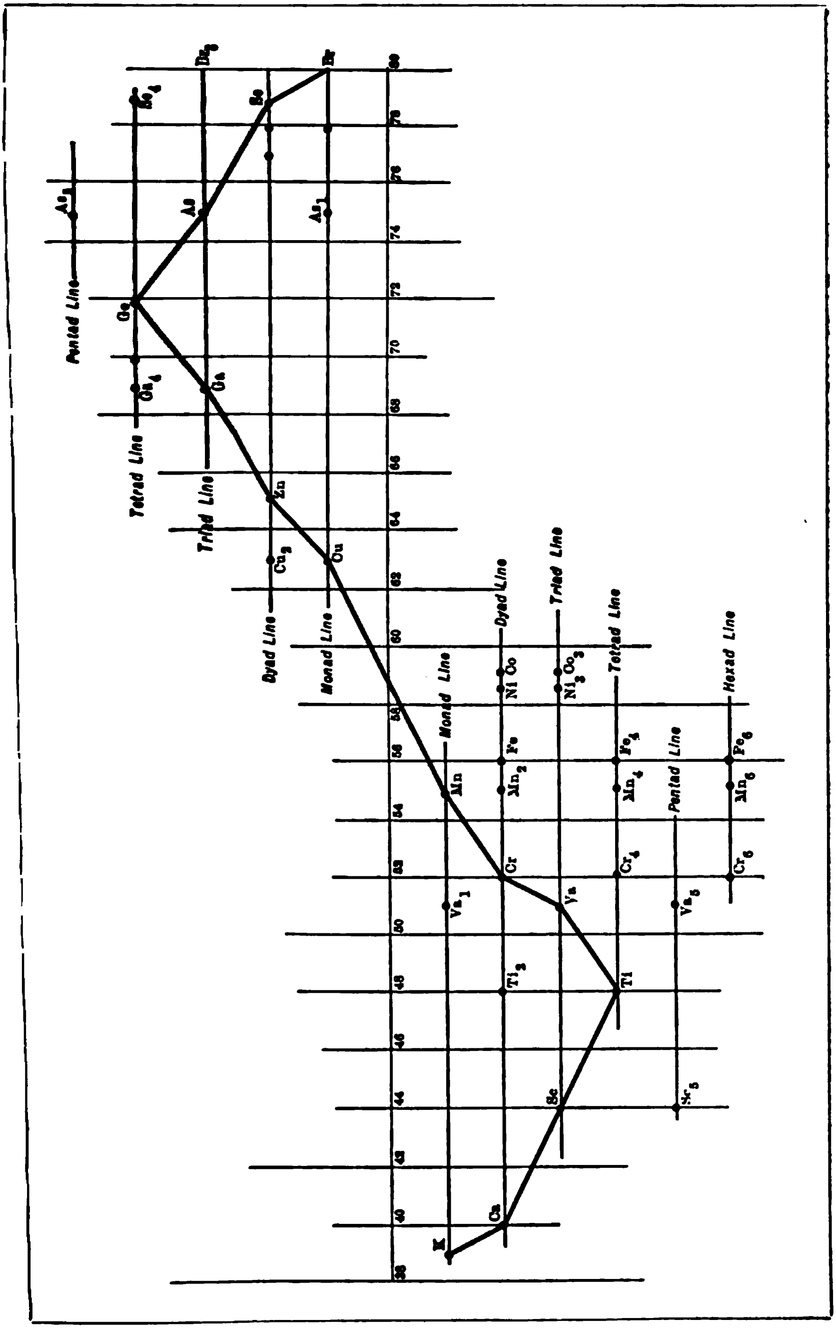
K | Ca | Sc.

The last three elements are also on the cubic branch, viz.—

As | Se | Br.

---

[1] I venture to call it a serpentine 'whiplash' cubic.


Pentad Line
Tetrad Line
Triad Line
Dyad Line
Monad Line
Dyad Line
Triad Line
Tetrad Line
Hexad Line
Monad Line
Pentad Line
Br
Se
As
Ge
Ga
Zn
Cu
Fe
Mn
Cr
Ti
Sc
Ca
K

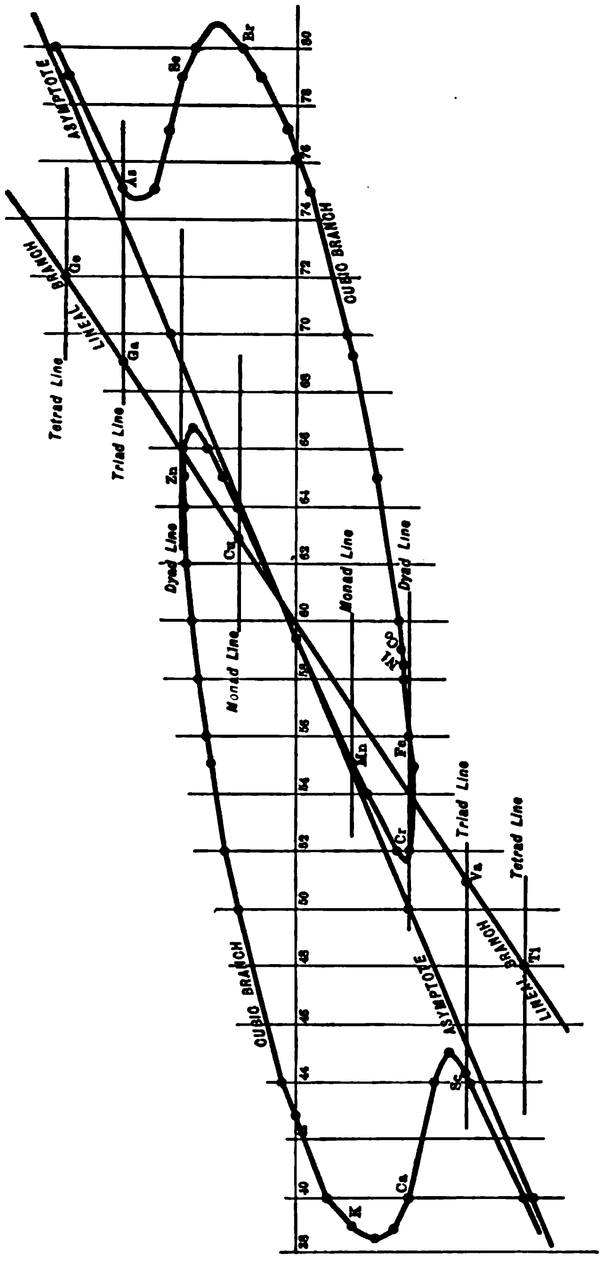
The central elements alternate as before between the lineal and cubic branches, viz.—

Mn cubic,	Mn (bis)	57 lineal,
Cu lineal,	Cu (bis)	64 cubic,
Zn cubic,	Zn (bis)	66 lineal,

with a possibility of forming three other elements near them, which have not come into existence.

The remaining elements are formed in pairs on the lineal branch, in the two gaps of the cubic branch, where two roots become imaginary, viz. Ti | Va, with a possibility of another element of atomic weight 50, forming a monad on the cubic at the opposite side, and, in the other gap, Ga | Ge |, with the possibility of another monad element of atomic weight 69½ at the opposite side.

[Note, see p. 96.


ASYMPTOTE
CUBIC BRANCH
LINEAL BRANCH
Tetrad Line
Triad Line
Dyad Line
Monad Line
Monad Line
Dyad Line
Triad Line
Tetrad Line
LINEAL BRANCH
ASYMPTOTE
CUBIC BRANCH
Br
Se
As
Ge
Ga
Zn
Cu
Fe
Mn
Cr
Va
Ti
Sc
Ca
K
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
40
38

NOTE.

TABLE OF *Fourteen Elements, with Name of Discoverer and Date.*

ELEMENT.	NAME.	DATE.
16. Potassium.	Davy.	1807
17. Calcium.	Davy.	1808
18. Scandium.	Nilson.	1879
19. Titanium.	Gregor.	1789
20. Vanadium.	Sefstrom.	1831
21. Chromium.	Vauquelin.	1797
22. Manganese.	Gahn.	1774
23. Copper.	——	Prehistoric.
24. Zinc.	Paracelsus.	xvi. century.
25. Gallium.	De Boisbaudran.	1875
26. Germanium.	Winkler.	1886
27. Arsenic.	Brandt.	1733
28. Selenium.	Berzelius.	1817
29. Bromine.	Balard.	1826
Additional Isolated Elements.		
30. Iron.	——	Prehistoric.
31. Nickel.	Cronstedt.	1751
32. Cobalt.	Brandt.	1735

XIII.

A REVISED CATALOGUE OF VARIABLE STARS, WITH NOTES AND OBSERVATIONS. BY J. E. GORE, M.R.I.A., F.R.A.S., Honorary Associate of the Liverpool Astronomical Society.

[Read JUNE 13, 1887.]

THE following is a revised Catalogue of all Stars now certainly known to be variable in light. All recent discoveries have been included, and a few variables added, which were inadvertently omitted in the first Catalogue. To avoid disturbing the numbering of the former Catalogue, lettered numbers are given to the new additions. A number of stars are added in a Provisional List which have been announced as variable, but of which the variability does not yet appear to be placed beyond doubt.

To avoid confusion in the future, distinctive letters (according to Argelander's nomenclature) have not—except in a few cases—been added to the new variables in the present Catalogue.

The positions of the variables have been brought up to 1890·0, and the latest observed dates of maxima and minima have been given when these could be obtained. In some cases, however, no recent observations were available, and for dates of maxima and minima the former Catalogue should be referred to.

Columns have been added showing colour and spectrum as far as hitherto observed. The colours have been derived from various sources, and the spectra have chiefly been observed by Dunér and Vogel. A few have been observed by Espin. The notation used for the spectra is that employed by Dunér in his valuable Paper, Sur les

Etoiles a Spectres de la Troisième Classe (Stockholm, 1885), and is as follows :—

Class I. includes spectra, in which the metallic lines are extremely faint (*faibles*) or entirely invisible. The blue and violet of the spectrum are strong, and the colour of the stars is usually white. This class is subdivided as follows :—

I. *a*. Spectra in which the hydrogen lines are very strong (as in Vega, Sirius, &c.).

I. *b*. Spectra in which the hydrogen lines are wanting.

I. *c*. Spectra where the hydrogen lines, and the line D_3 are brghti (as in β Lyræ and γ Cassiopeiæ).

Class II. includes spectra in which the metallic lines are numerous and easily visible. The blue and violet are relatively weak. In the red there are sometimes faint bands. This class is subdivided into—

II. *a*. Spectra with numerous metallic lines, especially in the yellow and green (Aldebaran, Pollux, Arcturus, &c.).

II. *b*. Spectra where, besides the dark lines and isolated bands, there are numerous bright lines (ex. T Coronæ, R Geminorum).

Class III. includes spectra in which, besides the metallic lines, there are numerous dark bands in all parts of the spectrum, and the blue and violet are remarkably faint. These stars are orange, or red, in colour. This class is subdivided as follows :—

III. *a*. Spectra, in which the dark bands have a dark sharp edge towards the violet, and shade away towards the red (as in α Herculis, α Orionis "Nova Orionis," α Pegasi, &c.).

III. *b*. Spectra, in which the dark bands shade away towards the violet (as in U Hydræ, 19 Piscium).

The sign ! denotes that the spectrum is fine; !! very fine; and !!! superb.

Additional information and observations are given in the Notes at the end of the Catalogue. The notes in the original Catalogue are not repeated in this, so that the notes now given may be considered as an Appendix to those in the first Catalogue.

The author's own observations were made near Ballysodare, County Sligo, with a binocular field glass.

[CATALOGUE OF VARIABLE STARS.

A REVISED CATALOGUE

No.	Star.	R.A., 1890.0			Decl., 1890.0		Change of Magnitude.		Mean Pe…
							Max.	Min.	Days.
		h.	m.	s.	°	′			
0a	Lalande, 405 Ceti, .	0	16	12	− 20	40·1	5·2	7·0	..
1	T Cassiopeiæ, . .	0	17	17	+ 55	10·9	6·5–7·0	11–11·2	436
2	R Andromedæ, .	0	18	13	+ 37	58·1	5·6–8·6	< 12·8	404·
3	S Ceti, ...	0	18	28	− 9	56·3	7·0–8·0	< 10·7	323·
[a]4	B Cassiopeiæ, . .	0	18	41	+ 63	32·1	> 1	?	?
5	T Piscium, . . .	0	26	18	+ 13	59·6	9·5–10·2	10·5–11·0	Irregul
6	α Cassiopeiæ, . .	0	34	16	+ 55	56	2·2	2·8	Irregul
[b]6a	Nova Andromedæ,	0	36	43	+ 40	39·9	7·0	< 15	?
6b	V Cassiopeiæ, . .	0	40	11	+ 47	39·2	8·5	14	260
[c]7	U Cephei, . . .	0	52	31	+ 81	17	7·2	9·1–9·4	2·
8	S Cassiopeiæ, . .	1	11	34	+ 72	1·9	6·7–8·5	< 13	615
9	S Piscium, . . .	1	11	50	+ 8	21·1	8·8–9·3	< 13	406·
9a	— Piscium, . .	1	17	8	+ 12	17·8	10	14	330
[d]10	R Sculptoris, . .	1	21	55	− 33	6·8	5·75	7·75	207?
11	R Piscium, . . .	1	24	57	+ 2	18·9	7·0–8·3	< 12·5	345
12	S Arietis, . . .	1	58	44	+ 12	0·3	9·1–9·8	< 13	288·
13	R Arietis, . . .	2	9	52	+ 24	32·3	7·6–9·0	11·9–12·7	186·
14	o (Mira) Ceti, . .	2	13	47	− 3	28·6	1·7–5·0	8·7–9·5	331·
[e]15	S Persei, . . .	2	14	58	+ 58	5·0	7·6	< 9·7	..
16	R Ceti, ...	2	20	24	− 0	40·5	7·9–8·7	< 12·8	167·1
[f]16a	U Ceti, ...	2	28	55	− 13	34·0	6·8–7·0	< 10·5	228
17	T Arietis, . . .	2	42	11	+ 17	3	7·9–8·2	9·4–9·7	324
18	ρ Persei, ...	2	58	7	+ 38	24·8	3·4	4·2	Irregul
19	β Persei (Algol), .	3	1	0	+ 40	31·9	2·2	3·7	2·8672
20	R. Persei, . . .	3	23	3	+ 35	17·7	7·7–9·2	12·5	210
[g]21	λ Tauri, ...	3	54	35	+ 12	10·8	3·4	4·2	3·9

a Nova, 1872. *b* Nova, 1885. *c* Algol type. *d* Colour, "Scarlet," Gould.

⟩RIABLE STARS.

ate of Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
57. Dec. 3.	1884. Dec. 4.	Chandler, 1882.	Reddish.	—
55. Oct. 16.	1873. Jan. 29.	Krüger, 1870.	Red.	III *a*
85. Jan. 10.	..	Argelander, 1868.	Red.	III *a* !!!
72. Dec. 22·2.	..	Borelly, 1872.	—	—
..	..	Cornelius Gemma, 1572.	—	—
72. Dec. 1.	..	R. Luther, 1855.	Trifling.	—
..	..	Birt, 1831.	Yellow.	II
..	..	I. W. Ward and other observers.	—	Continuous with bright lines ?
568. May 1.	..	Espin, 1886.	Red.	—
..	1885. Aug. 3, 11ʰ 53·5ᵐ.	Ceraski, 1880.	—	—
856. July 22 ±	..	Argelander, 1861.	Red.	—
868. May 8.	..	Hind, 1851.	Reddish.	—
..	..	Peters, 1880.	—	—
866. Jan. 5·7.	1878. Nov. 15.	Gould.	Very red.	—
1863. Nov. 17·5.	..	Hind, 1850.	Yellow red.	III *a* !!
1872. Mar. 17.	..	C. H. F. Peters, 1865.	Deep yellow.	—
1886. Feb. 6.	1886. Nov. 27.	Argelander, 1857.	Yellow red.	—
1887. Nov. 14.	1883. Nov. 28.	D. Fabricius, 1596.	Reddish yellow.	III *a* !!!
1885. April 2 ±.	..	Krüger, 1873.	Yellow red.	III *a* !
1870. Oct. 31·4.	..	Argelander, 1867.	Yellow red.	III *a* !
1888. Feb. 24.	..	Sawyer, 1884.	Reddish.	—
1873. Mar. 11.	1872. Nov. 8.	Auwers, 1870.	Gold yellow.	III *a* !!
..	..	Schmidt, 1854.	Yellow red.	III *a* !!!
..	1887. Feb. 9. 8ʰ 0ᵐ ·5, Cam. (U.S.A.), M.T.	Montanari, 1669.	White.	I
1885. Dec. 6.	..	Schönfeld, 1861.	Reddish.	—
..	..	Baxendell, 1848.	White.	I *a* !

e Spectrum according to Espin. *f* *Ast. Nach.* 2660. *g* Algol type.

No.	Star.	R A., 1890.0			Decl. 1890.0.		Change of Magnitude.		Mean Period — Days.
							Max.	Min.	
		H.	M.	S.	°	′			
22	T Tauri, . . .	4	15	35	+ 19	16·4	9·2–11·5	< 12·8	Irregular.
22*a*	— Tauri, . . .	4	21	42	+ 15	51·4	8·2 ±	< 13	360 ±
23	R Tauri	4	22	16	+ 9	54·9	7·4–9·0	< 13	325·6
24	S Tauri, . . .	4	23	10	+ 9	42·1	9·9	< 13	378
24*a*	R Reticuli, . . .	4	32	13	– 63	18·0	7·7	< 12	9 months.
25	R Doradus, . . .	4	35	30	– 62	17·6	5½	6¾	..
26	V Tauri, . . .	4	45	40	+ 17	21·1	8·3–9·0	< 12·8	168·6
27	R Eridani, . . .	4	50	36	– 16	35·7	5·4	6·0	..
28	R Orionis, . . .	4	53	2	+ 7	57·8	8·7–8·9	< 13	378·8
29	ε Aurigæ, . . .	4	54	4	+ 43	39·6	3·0	4·5 ?	Irregular.
30	R Leporis, . . .	4	54	36	– 14	58·3	6–7	8·5 ?	437·8
31	S (64) Eridani, . .	4	54	49	– 12	42·0	4·8	5·7	..
32	R Aurigæ, . . .	5	8	26	+ 53	27·7	6·5–7·4	9·2–12·7	465
33	S Aurigæ, . . .	5	19	50	+ 34	3·1	9·4	< 13	270 ±
34	S Orionis, . . .	5	23	35	– 4	46·9	8·3–9·0	< 12·3	412 ±
34*a*	31 Orionis, . . .	5	24	9	– 1	10·8	4¾	< 6	?
35	δ Orionis, . . .	5	26	23	– 0	22·9	2·2	2·7	Irregular.
36	T Orionis, . . .	5	29	11	+ 10	10·3	5·7 ?	6·7 ?	..
36*a*	— Orionis, . . .	5	30	27	– 5	32·9	9·7	12·8	..
37	α Orionis, . . .	5	49	13	+ 7	23·2	1	1·4	Irregular.
[a]37*a*	U ('Nova') Orionis,	5	49	17	+ 20	9·3	6·1–7·5	< 12	365 ±
38	η Geminorum, . .	6	8	14	+ 22	32·4	3·2	3·7–4·2	135–151
[b]38*a*	V Monocerotis, .	6	17	8	– 2	8·5	7	< 10	..
39	T Monocerotis, .	6	19	20	+ 7	8·7	6·2	7·6	26·76
40	R Monocerotis, .	6	33	10	+ 8	50·0	9·5	11·5	Irregular.
41	S (15) Monocerotis,	6	34	55	+ 9	59·7	4·9	5·4	$3^d\ 10^h\ 38^m$
42	R Lyncis, . . .	6	52	13	+ 55	29·1	9 ?	< 12·3	?
43	ζ Geminorum, . .	6	57	36	+ 20	43·9	3·7	4·5	$10^d\ 3^h\ 43^m$ 1…

a "Nova," 1885. *b* A. N., 2561.

e of Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
..	1886. Feb. 16.	Auwers, Chacornac, and Hind, 1861.	Trifling.	—
88. Mar. 17.	1888. Sept. 16.	Espin, 1886.	Very red.	—
63. Sept. 15.	..	Hind, 1849.	Very red.	III *a*!
50. Feb. 21.	..	Oudemans, 1855.	Trifling.	—
..	..	Ragoonatha Chary, 1867.	—	—
..	..	Thome, 1874?	Very red.	—
72. Sept. 24·3	..	Auwers, 1871.	Reddish.	—
..	..	Gould.	Reddish.	—
869. Oct. 18·6.	..	Hind, 1848.	Reddish.	—
884. Feb. 27.	1884. Mar. 28.	Fritsch, 1821.	Yellowish white.	II
883. Mar. 15.	1863. July 18.	Schmidt, 1855.	Very red.	III *b*
..	..	Gould.	—	—
883. Jan. 30·0.	1883. Nov. 3.	Argelander, 1862.	Red.	III *a*!!!
886. Mar. 7.	..	Dunér, 1881.	Very red.	III *b*
887. Jan. 29.	..	Webb, 1870.	Reddish.	III!
..	..	Gould.	Orange.	II *a*!
..	..	Sir J. Herschel, 1834.	White.	I *b*!
..	..	Thome.	"Ruddy."	—
..	..	Schmidt, 1878.	—	—
..	1887. Dec.	Sir J. Herschel, 1840.	Reddish orange.	III *a*!!!
1885. Dec. 13? 1886. Dec. 8.	1886. July.	Gore, 1885.	Orange red.	III *a*!!!
..	1870. April. 7.	Schmidt, 1865.	Reddish yellow.	III *a*!!
1884. Dec. 10?	..	Schönfeld, 1883.	Reddish.	—
1888. April 13.	1888. April 4.	Davis, 1871.	Yellow.	II *a*?
..	..	Schmidt, 1861.	—	—
..	..	Winnecke, 1867.	White?	I *a*
..	..	Krüger, 1874.	Reddish.	III!
..	..	Schmidt, 1847.	Strong yellow.	—

No.	Star.	R.A., 1890.0 H.	M.	S.	Decl. 1880.0 °	′	Change of Magnitude. Max.	Min.	Mean Pe[riod] Days.
44	R Geminorum, .	7	0	44	+ 22	52·4	6·6–7·3	< 12·3	371
45	R Canis Minoris, .	7	2	39	+ 10	11·8	7·2–7·9	9·5–10·0	335
46	L_2 Puppis, . . .	7	10	10	– 44	27·7	3·6	6·3	136
46A	R Canis Majoris, .	7	14	29	– 16	11·3	5·9	6·7	27 hou
46a	V Geminorum, .	7	16	59	+ 13	18·2	8·6	< 13½	276
47	U Monocerotis, .	7	25	32	– 9	32·8	6·0	7·2	31 to 5
48	S Canis Minoris, .	7	26	45	+ 8	33·2	7·2–8·0	< 11	332·1
49	T Canis Minoris, .	7	27	53	+ 11	58·8	9·1–9·7	< 13	326·2
49a	U Canis Minoris .	7	35	22	+ 8	38·2	8½	13·5	423±
50	S Geminorum . .	7	36	26	+ 23	42·6	8·2–8·7	< 13	294·2
51	R Puppis, . . .	7	36	36	– 31	24·3	6½	7½	..
52	T Geminorum, .	7	42	42	+ 24	0·4	8·1–8·7	< 13	288·1
53	S Puppis, . . .	7	43	32	– 47	50·5	7½	9	..
54	T Puppis, . . .	7	44	22	– 40	22·8	6½	7½	..
55	U Geminorum, .	7	48	34	+ 22	17·4	8·9–9·7	14½	86 ±
55a	— Puppis, . . .	7	55	42	– 12	34·4	8½	< 14	310
55b	— Cancri, . . .	8	3	17	+ 19	45·7	9·7	14	..
56	R ancri, . . .	8	10	30	+ 12	3·8	6·2–8·3	< 11·7	354·4
57	V Cancri, . . .	8	15	27	+ 17	38·1	6·8–7·7	< 12	272
58	U Cancri, . . .	8	29	28	+ 19	16·5	8·2–10·6	< 13	305·7
[a]59	S Cancri, . . .	8	37	39	+ 19	25·8	8·2	9·8–11·7	$9^d\ 11^h\ 37^m$
60	S Hydræ, . . .	8	47	49	+ 3	29·0	7·5–8·5	< 12·2	256·4
[b]61	T Cancri, . . .	8	50	24	+ 20	16·2	8·2–8·5	9·3–10·5	484·2
62	T Hydræ, . . .	8	50	25	– 8	43·3	7·0–8·1	< 12·5	289·4
62a	N Velorum, . .	2	27	54	– 56	32·9	3·4	4·4	4¼ ?
63	R Carinæ, . . .	9	29	29	– 62	18·1	4·3–5·4	9·3	313
64	R Leonis Minoris,	9	38	59	+ 35	1·1	6·1–7·5	< 11	374·7
65	R Leonis, . . .	9	41	39	+ 11	56·3	5·2–6·7	9·4–10·0	313

[a] Algol type. [b] Schönfeld says, "Ungemein roth."

of Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
Mar. 4.	..	Hind, 1848.	Very red.	II *b*
June 17.	1867. Jan. 30.	At Bonn, 1855.	Very red.	III *a* or III *b*
Jan. 20.	..	Gould, 1872.	Red.	—
..	1888. Feb. 6, $8^h\ 35^m\cdot5$, Cam. (U.S.A.), M.T.	Sawyer, 1887.	—	—
Feb. 20.	..	Baxendell, 1880.	—	—
Mar. 5.	1885. Feb. 17.	Gould, 1873.	Orange.	Continuous.
Jan. 20.	..	Hind, 1856.	Deep yellow.	III *a* !!
Feb. 3·6.	..	Schönfeld, 1865.	Trifling.	—
Nov.	1885. April 19.	Baxendell, 1879.	Reddish ?	—
Nov. 3·2.	..	Hind, 1848.	Yellow red.	—
..	..	Gould.	Red.	—
Feb. 18·3.	..	Hind, 1848.	—	III ?
..	..	Gould, 1874 ?	—	—
..	..	Gould, 1875 ?	Reddish.	—
6. Dec. 1·1. 7. Feb. 23·3.	..	Hind, 1855.	White max., reddish min.	Continuous.
..	..	Pickering, 1881.	—	III *b*
..	..	Peters.	—	—
13. Oct. 23.	..	Schwerd, 1829.	Yellow red.	III *a* !
13. April 17.	..	Auwers, 1870.	Yellow red.	III
14. Dec. 30.	..	Chacornac, 1853.	Reddish.	—
..	1885. Feb. 20, $16^h\ 22^m$.	Hind, 1848.	Faint yellow.	—
35. April 2.	..	Hind, 1848.	Reddish yellow.	III *a*
..	1868. Aug. 16·6.	Hind, 1850.	Very red.	IV ?
886. Jan. 26·5.	..	Hind, 1851.	Yellow red.	III !
..	..	At Cordoba.	Yellow.	—
86. Jan. 26.	1885. Aug. 31, to Sept. 6.	At Cordoba.	Red.	—
885. June 26.	..	Schönfeld, 1863.	Yellow red.	III *a* !!
884. Dec. 24.	1887. Feb. 23.	Koch, 1782.	Very red.	III *a* !!!

No.	Star.	R.A., 1890.0			Decl. 1890.0		Change of Magnitude.		Mean P[illegible]
							Max.	Min.	Day[illegible]
		H.	M.	S.	°	′			
66	*l* Carinæ, . . .	9	42	14	− 62	0·1	3·7	4·2	31[illegible]
66*a*	— Leonis, . . .	9	53	57	+ 21	47·2	8·6	< 13	250[illegible]
67	R Velorum, . .	10	2	1	− 51	39·2	6·5	7·5	..
68	R Antliæ, . . .	10	5	1	− 37	11·4	6·5	< 8	..
69	S Carinæ, . . .	10	5	52	− 61	0·6	6¼	9	7 mon[illegible]
69*a*	U Leonis, . . .	10	18	10	+ 14	33·6	9½	< 13	..
70	U Hydræ, . . .	10	32	7	− 12	48·6	4·3–5·2	6·1–6·3	194·[illegible]
71	R Ursæ Majoris, ′.	10	36	51	+ 69	21·2	6·0–8·1 ..	13·2	302·[illegible]
72	η Argûs, . . .	10	40	47	− 59	6·3	> 1	< 7	Irregul[illegible]
72*a*	— Leonis, . . .	10	47	50	+ 14	18·1	9	..	+ 36[illegible]
73	T Carinæ, . . .	10	50	53	− 59	56·0	6·2	6·9	..
74	R Crateris, . . .	10	55	9	− 17	44·1	> 8	< 9	..
75	S Leonis, . . .	11	5	9	+ 6	3·5	9·0–9·7	< 13	187·[illegible]
76	T Leonis, . . .	11	32	49	+ 3	59·0	10?	< 13	$\frac{110[illegible]}{n}$
77	X Virginis, . . .	11	56	13	+ 9	41·3	7·0	< 10	..
78	R Comæ, . . .	11	58	36	+ 19	23·8	7·4–8·0	< 13	363
79	T Virginis, . .	12	8	58	− 5	25·4	8·0–8·8	< 13	337
80	R Corvi, . . .	12	13	56	− 18	38·6	6·8–7·3	< 11·5	318·[illegible]
81	Z Virginis, . . .	12	28	12	− 3	48·9	8·0	14	219
82	T Ursæ Majoris, .	12	31	23	+ 60	5·6	6·4–8·5	13	255·6
83	R Virginis, . . .	12	32	55	+ 7	35·6	6·5–7·5	10–10·9	145·7
84	R Muscæ, . . .	12	35	23	− 68	48·2	6·6	7·4	0·8[illegible]
85	S Ursæ Majoris, .	12	39	8	+ 61	41·7	7·2–8·2	10·2–12·8	224·8
86	U Virginis, . . .	12	45	31	+ 6	8·7	7·7–8·1	12·2–12·8	207·4
87	W Virginis, . .	13	20	21	− 2	48·5	8·7–9·2	9·8–10·4	17·27
88	V Virginis, . . .	13	22	7	+ 2	36·2	8·0–9·0	< 13	251
89	R Hydræ, . . .	13	23	43	− 22	42·7	4·0–5·0	10?	434 ±
90	S Virginis, . . .	13	27	15	− 6	37·7	5·7–7·8	12·75	374·0

of Maximum.	Date of Minimum.		Discoverer.		Colour.	Spectrum.
..		..	At Cordoba,	1871.	Yellow.	—
April. 4 ±		..	Becker,	1882.	—	—
..		..	Thome.		—	—
..		..	Gould,	1872.	—	—
..		..	Gould,	1871.	Reddish.	—
..		..	Peters,	1876.	—	—
. Dec. 11·78.		..	Birmingham and Gould.		—	III *b* !!!
. Feb. 21.	1887.	Sept. 13.	Pogson,	1853.	Reddish.	III *a* !!
..		..	Burchell,	1827.	Orange.	Bright lines.
..		..	Peters.		—	—
..		..	Thome,	1872.	—	—
..		..	Winnecke,	1871.	Very red.	III *a* !!
3. Sept. 14·3		..	Chacornac,	1856.	Yellowish.	—
..		..	Peters,	1862.	—	—
..		..	Peters,	1871.	—	—
3. Oct. 22.		..	Schönfeld,	1856.	Reddish.	—
5. Dec. 16.		..	Boguslawski,	1849.	Very red.	III ?
0. Dec. 2·73.		..	Karlinski,	1867.	Red.	III *a* !
2 Oct.		..	M. M. Henry,	1874.	—	—
6. Nov. 17.	1885.	Nov. 28.	Hencke,	1856.	Red yellow.	III *a*
6. April 9 ±		..	Harding,	1809.	Red yellow.	III *a* !
..		..	Gould,	1871.	None.	—
7. Mar. 13.	1887.	July 11.	Pogson,	1853.	Strong red yellow.	III *a*
3. June 18·5.	1866.	Mar. 28·3	Harding,	1831.	Reddish.	III *a* !!
..		..	Schönfeld,	1866.	Reddish.	III ?
57. Sept. 4.		..	Goldschmidt,	1857.	Yellow red.	III ?
33. May 9.		..	Maraldi,	1704.	Strong red.	III *a* !!!
53. May 12·6.	1883.	July 4.	Hind,	1852.	Strong red yellow.	III !!

No.	Star.	R.A., 1890.0			Decl. 1890.0		Change of magnitude.		Mean P… — Days
							Max.	Min.	
		H.	M.	S.	°	′			
91	Y Virginis, . . .	13	28	50	− 12	38·9	5	8 ?	?
91a	— Virginis, . .	13	59	3	− 8	40·2	11·0	< 13	365
91b	— Virginis, . .	14	4	25	− 12	46·9	9	14	..
92	R Centauri, . .	14	8	39	− 59	24·0	6	10	..
93	T Bootis, . . .	14	8	56	+ 19	34·9	9·7 ?	< 13	..
[a] 93a	— Bootis, . . .	14	18	59	+ 16	49·2	9·2	10·2	121·…
94	S Bootis, . . .	14	19	12	+ 54	18·2	8·1–9·4	13·6	272·…
94a	V Bootis, . . .	14	25	19	+ 39	21·0	7·0	9·4	266·…
95	R Camelopardi, .	14	25	54	+ 84	19·9	7·8–8·6	12 ?	258·…
96	R Bootis, . . .	14	32	21	+ 27	12·8	5·9–7·8	11·3–12·2	223·…
96a	— Libræ, . . .	14	34	14	− 17	10·9	9·3	12·2	..
96b	34 Bootis, . . .	14	38	35	+ 26	59·8	5·2	6·1	361 …
96c	U Bootis, . . .	14	49	14	+ 18	8·6	9–9·5	13·5	175·…
[b] 97	δ Libræ, ...	14	55	6	− 8	4·8	4·9	6·1	$2^{d}\ 7^{h}\ 51^{m}$…
98	T Trian. Australis,	14	59	29	− 68	17·7	7·0	7·4	1 …
98a	— Libræ, . . .	15	4	28	− 19	35·9	10	< 13·5	700 …
99	R Trian. Australis,	15	9	56	− 66	5·5	6·6	8·0	3·…
[c] 100	U Coronæ, . . .	15	13	43	+ 32	3·0	7·6	8·8	$3^{d}\ 10^{h}\ 51^{m}$…
101	S Libræ, . . .	15	15	5	− 19	59·4	8·0	12·5	190 …
102	S Serpentis, . .	15	16	30	+ 14	42·5	7·6–8·6	12·5 ?	361
103	S Coronæ, . . .	15	16	55	+ 31	45·8	6·1–7·8	11·9–12·5	360·…
104	T Libræ, . . .	15	29	51	− 20	47·9	11	< 14	302 or …
105	U Libræ, . . .	15	31	37	− 15	48·6	11	< 13	380 or …
[d] 106	— Libræ, . . .	15	35	38	− 20	49·5	9	< 14	228
106a	— Libræ, . . .	15	40	6	− 20	47·1	11	< 13	< 1 yea…
[e] 107	R Coronæ, . . .	15	44	4	+ 28	29·7	5·8	13	Irregula…
108	R Serpentis, . .	15	45	37	+ 15	28·1	5·6–7·6	< 11	357·6
109	V Coronæ, . . .	15	45	35	+ 39	54·2	7·5	12	357·03

[a] Baxendell's V Bootis. [b] Algol type. [c] Algol type. [d] Oe. Arg. 14782. [e] Schönfeld says "…

of Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
..	..	Schmidt, 1866.	Yellowish white.	—
..	..	Peters, 1880.	—	—
..	..	Palisa, 1880.	—	—
June 28 ±	..	Gould, 1871.	Red.	—
..	..	Baxendell, 1860.	—	—
. June 26.	1884. Aug. 7.	Baxendell, 1859.	Dull orange.	—
. May 12.	1885. April 4.	Argelander, 1860.	Reddish.	—
..	..	Dunér, 1884.	—	III *a* ! !
. Nov. 14.	..	Hencke, 1858.	Reddish.	III *a*
. May 16.	1886. April 26.	Argelander, 1858.	Red.	III *a* ! !
..	..	Schönfeld, 1885.	—	—
. Feb. 24.	..	Schmidt, 1867.	Orange.	III *a* !
5. June 23.	1886. Mar. 17.	Baxendell, 1880.	—	—
..	..	Schmidt, 1859.	Yellowish white.	—
..	..	Gould.	None.	—
..	..	Palisa, 1878.	—	—
..	..	Gould, 1871.	None.	—
..	..	Winnecke, 1869.	Trifling.	—
..	..	Borelly, 1872.	Somewhat reddish.	III *a* !
73. June 27.	..	Harding, 1828.	Red.	III ! ! !
87. April 29.	..	Hencke, 1860.	Red yellow.	III *a* ! !
..	..	Peters, 1880.	—	—
..	..	Peters, 1880.	—	—
60. May 18.	..	Peters, 1880.	—	—
..	..	Peters.	—	—
..	1883. Aug.	Pigott, 1795.	Yellow.	Continuous.
82. Feb.	..	Harding, 1826.	—	III ! !
83. Sept. 5.	..	Dunér, 1878.	Yellow red.	III *b*

No.	Star.	R.A., 1890.0 h.	m.	s.	Decl. 1890.0 °	′	Change of Magnitude. Max.	Min.	Mean P[...] Day[...]
109*a*	— Lupi,	15	46	20	− 35	58·0	9·0	12	..
110	R Libræ,	15	47	22	− 15	54·5	9·2–10·0	< 13	723
110*a*	— Libræ,	15	50	4	− 17	58·9	8½	12	..
[a]111	T Coronæ,	15	54	54	+ 26	14·1	2·0	9·5	?
112	R Herculis,	16	1	16	+ 18	41·0	8·0–9·0	< 13	319
113	— Scorpii,	16	2	5	− 21	13·9	11 ?	?	405, or [...]
[b]114	— Scorpii,	16	5	20	− 19	51·0	10 ?	< 13	224·[...]
[c]115	T Scorpii,	16	10	29	− 22	42·1	7·0	< 10	..
116	R Scorpii,	16	11	5	− 22	40·3	9–10·5	< 12·5	223
117	S Scorpii,	16	11	7	− 22	37·3	9·1–10·5	< 12·5	176·9
117*a*	— Ophiuchi,	16	15	29	− 7	26·2	9	< 11	326
118	U Scorpii,	16	16	8	− 17	37·6	9 ?	< 12	..
118*a*	— Ophiuchi,	16	20	37	− 12	10·0	7·1	9·6	309 ±
119	U Herculis,	16	20	57	+ 19	8·5	6·6–7·7	11·4–11·6	408·3
120	X Scorpii,	16	23	14	− 19	16·1	11·5	< 13	$\frac{1394}{n}$
121	g (30) Herculis,	16	25	2	+ 42	7·6	5	6·2	40–125
122	T Ophiuchi,	16	27	27	− 15	53·8	10	< 12·5	..
123	S Ophiuchi,	16	27	56	− 16	55·7	8·3–9·0	< 12·5	233·8
[d]124	— Herculis,	16	31	18	+ 37	33·9	8·0	< 11·5	281·2
125	R Ursæ Minoris,	16	31	32	+ 72	30·0	8·6	10·5	166 ?
125*a*	R Draconis,	16	32	21	+ 67	2·5	7–8·7	< 13	244·5
126	S Herculis,	16	46	53	+ 15	7·7	5·9–7·7	11·5–12·2	303
[e]127	— Ophiuchi,	16	53	20	− 12	43·5	4½	?	..
[f]127*a*	— Herculis,	16	54	14	+ 35	13·9	9·0	11·7	..
128	R Ophiuchi,	17	1	24	− 15	56·1	7·6–8·1..	< 12	302·4
129	*a* Herculis,	17	9	38	+ 14	31·0	3·1	3·9	Irregular.
[g]130	U Ophiuchi,	17	10	57	+ 1	20·1	6·1	6·8	0d 20h 7m 41[...]
131	u (68) Herculis,	17	13	16	+ 33	13·1	4·6	5·4	37–40

a Nova, 1866. *b* W. Scorpii, Pickering. *c* Nova, 1860. *d* W Herculis, Pickering.

…of Maximum.	Date of Min.	Discoverer.	Colour.	Spectrum.
..	..	Gould, 1885.	—	—
April 8,	..	Pogson, 1858	Somewhat reddish.	—
June ?	..	Peters, 1885.	—	—
May 12.	..	Birmingham, 1866.	Yellow.	Bright lines.
July 21.	..	Argelander, 1855.	Red.	—
Aug.	..	Peters, 1880.	—	—
July 9·7.	..	Palisa, 1877.	—	—
..	..	Auwers and Pogson, 1860.	—	—
6. July 28.	..	Chacornac, 1853.	Trifling.	—
3. May 14·5	..	Chacornac, 1854.	Trifling.	—
..	..	Schönfeld, 1881.	—	—
..	..	Pogson, 1863.	—	—
5. Mar. (end).	..	Birmingham, 1876. Dunér, 1883.	Very red.	III *b* !!
4. May 31. 5. July 8.	..	Hencke, 1860.	Red yellow.	III *a* !!
..	..	Peters, 1880.	—	--
84. Oct. 22.	1887. June 9.	Baxendell, 1857.	Red yellow.	III *a* !!!
..	..	Pogson, 1860.	—	—
65. Mar. 4·4.	..	Pogson, 1854.	Yellowish white.	—
85. Sept.	..	Dunér, 1880.	Red yellow.	III *a* !
84. Dec. 1.	1885. Sept. 27.	Pickering, 1881.	Red.	III *a*
86. Jan. 2.	..	Geelmuyden, 1876.	Yellow red.	III *a*
85. June 11.	..	Schönfeld, 1856.	Red yellow.	III *a* !
48. May 3.	..	Hind, 1848.	Very red.	—
..	..	Baxendell, 1880.	—	—
865. Oct. 21·7.	..	Pogson, 1853.	Faint red.	III *a* !!
..	..	Sir W. Herschel, 1795.	Orange.	III *a* !!!
..	1884. June 22, $10^h 29^m \cdot 4$ Camb. (U.S.A.), M.T.	Sawyer, 1881.	Trifling.	I *a*
..	..	Schmidt, 1869.	Reddish.	—

e Nova, 1848. Schönfeld says "grell roth"   *f* V Herculis, Pickering.   *g* Algol type.

No.	Star.	R.A., 1890.0			Decl. 1890.0		Change of Magnitude.		Mean P
							Max.	Min.	Day
		H.	M.	S.	°	′			
[a]132	Nova Serpentarii, .	17	24	3	− 21	23·3	> 1	?	?
133	X (3) Sagittarii, .	17	40	38	− 27	47·2	4	6	7·
134	W (γ′) Sagittarii, .	17	58	0	− 29	35·1	5	6·5	7·
135	T Herculis, . . .	18	4	56	+ 31	0·1	6·9–8·3	11·4–12·7	165·
135*a*	— Sagittarii, . .	18	14	55	− 18	54·5	5·6	6·6	5·
136	T Serpentis, . .	18	23	27	+ 6	13·6	9·1–10·0	< 12·8	342·
137	V Sagittarii, . .	18	24	58	− 18	20·3	7·5 ?	9·5 ?	..
138	U Sagittarii, . .	18	25	24	− 19	12·3	7·0	8·3	6·7
138*a*	— Serpentis, . .	18	33	4	+ 8	43·7	6·8	9·0	300
139	T Aquilæ, . . .	18	40	28	+ 8	37·7	8·8	9·5	Irregul
140	R Scuti, . . .	18	41	36	− 5	49·8	4·7–5·7	6·0–8·5	..
141	κ Pavonis, . . .	18	45	37	− 67	22·3	4 0	5·5	9·1
142	β Lyræ, ...	18	46	1	+ 33	14·1	3·4	4·5	12·9
143	R (13) Lyræ, . .	18	52	0	+ 43	48·0	4·3	4·6	46 ?
144	S Coronæ Australis,	18	53	43	− 37	6·5	9·8	11·5 ?	6·2
145	R Coronæ Australis,	18	54	28	− 37	6·4	10·5–11·5	< 12·5	31 ?
[b]146	R Aquilæ, . . .	19	1	5	+ 8	3·8	6·4–7·4	10·9–11·2	345·1
147	T Sagittarii, . .	19	9	54	− 17	9·8	7·6–8·1	< 11	381
148	R Sagittarii, . .	19	10	14	− 19	30·0	7·0–7·2	< 12	270
149	S Sagittarii, . .	19	13	0	− 19	13·4	9·7–10·4	< 12·7	230
149*a*	U Aquilæ, . . .	19	23	26	− 7	16·2	6·3	7·3	7 ±
150	*h*′ (51) Sagittarii, .	19	29	21	− 24	57·6	5·3	6·7	..
151	R Cygni, . . .	19	33	52	+ 49	57·2	5·9–8·0	< 13	425·3
[c]152	Nova Vulpeculæ, .	19	43	3	+ 27	2·6	3	?	..
153	S Vulpeculæ, . .	19	43	53	+ 27	0·8	8·85	9·95	67·79
154	χ Cygni, . . .	19	46	20	+ 32	38·2	4·0–6·0	12·8	406·5
155	η Aquilæ, . . .	19	46	52	+ 0	43·4	3·5	4·7	7d 4h 14m
155*a*	S (10) Sagittæ, . .	19	51	0	+ 16	21	5·6	6·4	8·38

[a] Nova, 1604.   [b] Schönfeld says "ausgezeichnet roth."   [c] Nova, 1670.

of Max.	Date of Min.	Discoverer.	Colour.	Spectrum.
..	..	J. Brunowski, 1604.	—	—
..	..	Schmidt, 1866.	Yellow.	—
..	..	Schmidt, 1866.	Yellow.	—
April 28.	1886. Dec. 6.	Argelander, 1857.	Reddish.	—
Sep. 24·83.	..	Sawyer, 1886.	—	—
Sept. 14.	..	Baxendell, 1860.	Deep yellow red.	—
..	..	Quirling, 1865.	—	—
Oct. 30·7	1883. Oct. 20·62,	Schmidt, 1866.	Yellow red.	—
Feb. 18.	..	Espin, 1886.	Red.	III *a*!!!
..	..	Winnecke, 1860.	"Plum colour."	—
Nov. 16. Oct. 27.	1887. Nov. 23.	Pigott, 1795.	Red.	—
..	..	Thome, 1872.	—	—
..	..	Goodricke, 1784.	Yellowish white.	Bright lines.
..	..	Baxendell, 1856.	Red.	III *a*!!!
..	..	Schmidt, 1866.	—	—
..	..	Schmidt, 1866.	—	—
Feb. 10·7.	1864. Sept. 27.	Argelander, 1856.	Very red.	III *a*!!
Oct. 17.	..	Pogson, 1863.	Reddish.	—
June 28.	..	Pogson, 1858.	Red yellow.	III *a*!!
Nov. 20.	..	Pogson, 1860.	Trifling.	—
Sept. 20·01	Cam. (U.S.A.)M.T.	Sawyer, 1886.	—	—
..	..	At Cordoba.	Pale yellow.	—
Mar. 22.	..	Pogson, 1852.	Very red.	III *a*!
..	..	Anthelm, 1670.	—	—
Oct. 22.	1886. Dec. 15.	Rogerson, 1837.	Yellow red.	III *a*
Nov. 23.	..	Kirch, 1686.	Very red.	III *a*!!!
..	..	Pigott, 1784.	Yellow.	II *a*
..	..	Gore, 1885.	Pale yellow.	—

No.	Star.	R.A., 1890.0			Decl. 1890.0		Charge of Magnitude.		Mean D…
		H.	M.	S.	°	′	Max.	Min.	
155b	— Cygni, . . .	19	58	20	+ 49	44·2	7·1	< 13	..
156	S Cygni, . . .	20	3	14	+ 57	40·2	8·8–10·1	< 13	32…
157	R Capricorni, . .	20	5	8	− 14	35·7	8·8–9·7	< 13	34…
[a]158	S Aquilæ, . . .	20	6	34	+ 15	17·6	8·4–9·9	10·7–11·7	146–…
[b]159	– Sagittarii, . .	20	8	1	− 22	18·7	11	< 13	1 4 …
160	R Sagittæ, . . .	20	9	2	+ 16	23·6	8·5–8·7	9·8–10·4	7…
161	R Delphini, . .	20	9	36	+ 8	45·3	7·6–8·5	12·8	294…
[c]161a	V Capricorni, . .	20	10	40	− 21	38·4	6·5 ?	8·5 ?	?
[d]162	P (34) Cygni, . .	20	13	44	+ 37	41·5	3–5	< 6 ?	..
163	U Cygni, . . .	20	16	11	+ 47	32·9	7·5–7·8	< 11	461…
[e]164	R Cephei, . . .	20	7	36	+ 88	47·8	5 ?	10 ?	?
165	— Capricorni, . .	20	35	17	− 19	24·0	9	11	..
165a	V Cygni, . . .	20	37	46	+ 47	44·9	6·8–9·5	13	440 …
[f]166	S Delphini, . .	20	38	1	+ 16	41·5	8·4–9·0	10·4–11·1	275·…
166a	X Cygni, . . .	20	39	5	+ 35	11·4	6·4	7·2–7·7	15·…
[g]167	T Delphini, . .	20	40	15	+ 16	0·0	8·2–10·1	< 13	331·…
167a	— Delphini, . .	20	40	25	+ 17	41·5	6·3	7·4	111 ±…
168	U Capricorni, . .	20	42	1	− 15	11·2	10·2–10·8	< 13	203·…
169	T Cygni, . . .	20	42	47	+ 33	58·2	5·5 ?	6 ?	365 ?…
170	T Aquarii, . . .	20	44	8	− 5	33·2	6·7–7·8	12·4–12·7	203·…
170a	— Vulpeculæ, . .	20	46	34	+ 27	48·9	5·5	6·6	4·4…
[h]170b	— Cygni, . . .	20	47	44	+ 34	15·1	7·1	7·9	1d 12h …
171	R Vulpeculæ, . .	20	59	30	+ 23	23·1	7·5–8·5	12·5–13·0	137·…
172	— Capricorni, . .	21	0	12	− 24	21·8	9½	< 13·0	326 or …
173	— Capricorni, . .	21	2	15	− 21	47·5	11·5 ?	< 13	217 ±
174	63 Cygni, . . .	21	2	48	+ 47	12	4·7	6	± 5 years
175	T Cephei, . . .	21	7	59	+ 68	2·6	6·2–6·7	9·5–9·9	390 ±
176	T Capricorni, . .	21	15	56	− 15	37·4	8·9–9·7	< 13	269·4

a T Aquilæ, Baxendell. b $n = 2$, or $n = 4$. c Variation confirmed by Safarik and Gore.

[...] Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
Mar. 28 ±	..	Espin, 1887.	Pale red.	III *a* !!!
Aug. 11 ±	..	Argelander, 1860.	Reddish.	—
Oct. 3.	..	Hind, 1848.	Red.	—
Nov. 23.	1886. Dec. 2.	Baxendell, 1863.	Reddish.	—
June.	..	Peters, 1880.	—	—
Nov. 27.	1886. Nov. 10.	Baxendell, 1859.	Yellow red.	—
July 13·6.	..	Hencke, 1851. Schönfeld, 1859.	Reddish.	—
..	..	Secchi, 1869.	'Ruby.'	III *b* !
..	..	Janson, 1600.	Yellow.	Bright lines
Aug. 17 ±	1887. May 31.	Knott, 1871.	Very red.	III *b*
..	..	Pogson, 1856.	Reddish ?	—
..	..	Hind, 1854.	—	—
Dec. 30.	1885. May 31.	Birmingham, 1881.	—	III *b* !
Oct. 15.	1885. June 25.	Baxendell, 1860.	Yellow red.	—
..	..	Chandler, 1886.	—	—
July 1.	..	Baxendell, 1863.	Yellow red.	—
..	..	Espin, 1884.	Red.	III *a* !!!
Sept. 19.	..	Pogson, 1858.	—	—
..	..	Schmidt, 1864.	Yellowish white.	—
July 31.	1870. July 20.	Goldschmidt, 1861.	Reddish.	—
..	..	Sawyer, 1885.	—	—
..	1886. Dec. 9, $6^h 22^m$ Cam. (U.S.A.), M.T.	Chandler, 1886.	—	—
Oct. 20 ±	1887. Aug. 21 ±	Argelander, 1858.	Yellow red.	III *a*
July.	..	Peters, 1880.	—	—
Sept.	..	Peters, 1880.	—	—
..	..	Espin, 1882.	Yellow.	—
Mar. 26.	1887. Nov. 14.	Ceraski, 1879.	Red.	III *a* !!!
..	..	Hind, 1854.	Faint yellow.	—

[...]ova, 1600. *e* Pogson, "bluish" (!) *f* R Delphini, Baxendell. *g* S Delphini, Baxendell. *h* Algol type.

No.	Star.	R.A., 1890.0			Decl. 1890.0		Change of Magnitude.		Mean Da
							Max.	Min.	
		H.	M.	S.	°	′			
[a]176a	W Cygni, . . .	21	31	53	+ 44	52·9	5·8–6·2	6·7–7·3	120-
177	S Cephei, . . .	21	36	35	+ 78	7·7	7·4–8·5	11·5	48
[b]178	Nova Cygni, . .	21	37	23	+ 42	20·4	3	?	?
179	μ Cephei, . . .	29	40	8	+ 58	16·5	3·7	4·8	Irreg
179a	— Aquarii, . . .	21	57	20	– 17	9·4	11	< 13	200-
180	T Pegasi, . . .	22	3	32	+ 12	0·1	8·8–9·3	< 12·5	367
180a	R(?)Piscis Australis,	22	11	45	– 30	9·2	8·5	11	..
181	δ Cephei, . . .	22	25	5	+ 57	51·1	3·7	4·9	5d 8h 47m
181a	R Indi, ...	22	28	8	– 67	51·3	8	< 11	..
182	— Aquarii, . . .	22	30	7	– 8	10·6	9	< 13·5	?
182a	R Lacertæ, . . .	22	38	24	+ 41	47·8	8·6	< 13·5	315
183	S Aquarii, . . .	22	51	13	– 20	55·8	7·7–9·1	< 11·5	279·4
184	β Pegasi, . . .	22	58	27	+ 27	29·2	2·2	2·7	Irregul
185	R Pegasi, . . .	23	1	7	+ 9	57·0	6·9–7·7	12 ?	382
186	S Pegasi, . . .	23	14	59	+ 8	19·1	7·6	< 12·2	316
187	R Aquarii, . . .	23	38	7	– 15	53·7	5·8–8·5	11 ?	363
187a	19 Piscium, . . .	23	40	56	+ 2	52·7	4·8–5·2	6·3	165 ±
187b	— Phœnicis, . .	23	50	44	– 50	24·0	8·5	< 11	..
[c]188	— Ceti, ...	23	52	16	– 9	34·4	9·7	< 13	228
189	R Cassiopeiæ, . .	53	52	49	+ 50	46·5	4·8–6·8	< 12	429 ±
190	U Cassiopeiæ, . .	13	55	39	+ 59	44·5	6	9	..

[a] Birm. 587 = DM 44°, 3877. [b] Nova, 1876. [c] *Ast. Nach.* 2360.

…f Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
Jan. 29.	1887. Dec. 8.	Gore, 1884.	Reddish.	III *a* !!!
..	1864. Oct. 15.	Hencke, 1858.	Very red.	III *b* !
..	..	Schmidt, 1876.	Deep yellow.	Bright lines.
May 11 ±	1883. Sept. 4 ±	Sir W. Herschel, 1782.	"Garnet."	III *a* !!
..	..	Peters.	—	—
Nov. 9.	..	Hind, 1863.	Reddish.	—
..	..	At Cordoba.	—	—
..	..	Goodricke, 1784.	Orange.	—
..	..	At Cordoba.	—	—
..	..	?	—	—
. Feb. 2 ±	..	Deichmüller, 1883.	Orange.	—
. Aug. 8.	..	At Bonn, 1853.	Golden yellow.	—
l. Nov. 14.	1883. Dec. 3.	Schmidt, 1847.	Yellow red.	III *a* ¡ !!
l. May 24 ±	..	Hind, 1848.	Red.	—
..	..	Marth, 1864?	Yellowish red.	—
5. Jan. 4.	..	Harding, 1811.	Very red.	III *a* !
4. Aug. 19.	..	Gould and Espin.	Orange to orange red.	III *b* !!!
..	..	Gould. 1885.	—	—
..	..	Peters, 1880.	—	—
5. Feb. 6.	..	Pogson, 1853.	Very red.	—
..	..	Birmingham & Secchi	Very red.	III *a* ?

PROVISION

No.	Star.	R.A., 1890.0			Decl. 1890.0		Charge of Magnitude.		Mean Pe[riod]
							Max.	Min.	Days.
		H.	M.	S.	°	′			
1	— Piscium, . .	0	16	19	+ 6	22·6	7	9	..
2	Lalande, 2598, .	1	20	16	− 4	31·9	6·5	7·8	..
3	100 Piscium, . .	1	28	55	+ 11	59·5	7	9	..
4	Lalande, 7172 Tauri,	3	47	17	+ 7	26·9	6¾	8	..
5	π Puppis, . . .	7	13	16	− 36	54·1	2·3	3·3	..
6	— Puppis, . . .	7	22	41	− 11	20·1	5·9	6·6	14 ±
7	Lacaille, 3105 Puppis,	7	55	5	− 48	56·7	4·5	5·2	4·2
8	R Pyxidis, . . .	8	48	21	− 36	7·8	6½	7½	..
[a]9	— Cancri, . . .	8	52	17	+ 11	15·5	7·7	8·6	..
10	74 Cancri, . . .	9	2	2	+ 15	9·5	7	9	..
11	— Sextantis, . .	9	41	34	+ 7	8·6	6	9	..
12	— Leonis, . . .	10	6	4	+ 13	8·5	9	< 13	..
12a	LL 20918 Hydræ .	10	46	17	− 20	37·9	6 ?	9 ?	?
13	Birm. 277 Virginis,	12	19	37	+ 1	23	6·5	8·5	..
14	Birm., 290 Can. Venat.,	12	39	57	+ 46	2·5	4·5 ?	6·5	380 ?
15	Lacaille, 6077 Apodis,	14	45	30	− 76	12·8	5½	6¼	..
16	— Libræ, . . .	15	20	44	− 19	36·1	12	< 13	..
17	— Libræ, . . .	15	37	12	− 10	34·2	7	8·8	4 months
18	— Ophiuchi, . .	17	19	48	− 22	14·3	11	13	..
19	Lacaille, 7646 Sagittarii	18	10	19	− 34	8·8	6·2	7·4	2·4?
[b]20	B. 535 Cygni, . .	20	6	7	+ 47	31·4	7·5 ?	9·4 ?	271 ±
21	DM + 35, 4002 Cygni,	20	6	14	+ 35	37·0	8·5	10	..
[c]22	B. 541 Cygni, . .	20	9	23	+ 38	23·5	6·6 ±	8·0 ±	..
23	— Capricorni, . .	20	21	48	− 17	39·1	11	< 13	..
24	ρ Capricorni, . .	20	22	35	− 18	10	4	6	..
25	Anon. Capricorni, .	20	24	23	− 12	36·3	6¾	8½	..

[a] DM + 11°, 1954. [b] DM + 47°, 3031. [c] DM + 38°, 3957.

f Maximum.	Date of Minimum.	Discoverer.	Colour.	Spectrum.
..	..	Borelly, 1885.	—	—
..	..	Gould, 1872.	—	—
..	..	Borelly, 1885.	Yellow.	—
..	..	At Cordoba.	—	—
..	..	At Cordoba.	Orange.	—
. April 3.	..	Espin, 1883.	Yellow.	—
..	..	S. Williams, 1886.	—	—
..	..	At Cordoba, 1874.	—	—
..	..	Baxendell.	"Ruddy."	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Birm. Chandler.	Very red.	—
..	..	Birmingham.	"Scarlet."	III *b* !!
'6. April 2.	1866. Aug. 15.	Schmidt.	Orange.	III *b* !!!
..	..	At Cordoba.	Red.	—
..	..	Borelly, 1885.	—	—
..	..	Weiss.	—	—
..	..	Borelly, 1885.	—	—
..	..	Gould.	—	—
86. July 10 ?	1886. April.	Espin, 1886.	Red.	—
..	..	Espin, 1886.	Red.	III *b* !!
..	..	Espin, 1887.	Red.	IV !
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	Yellowish white.	—
..	..	At Cordoba.	—	—

No.	Star.	R.A., 1890.0			Decl. 1890.o.		Change of Magnitude.		Mean Pe-
							Max.	Min.	Days.
		H.	M.	S.	°	′			
26	DM + 39°, 4208 Cygni,	20	24	50	+ 39	36·7	7·9 ?	9·2 ?	..
26*a*	Anon. Cygni, . .	20	41	19	+ 44	27·7	8·1 ?	?	..
27	— Capricorni, . .	21	1	3	– 16	12·9	7	9	..
28	— Aquarii, . . .	21	2	6	– 14	51·9	12	< 13	..
29	— Capricorni, . .	21	4	23	– 16	37·9	10·5	13	..
30	— Aquarii, . . .	21	9	3	– 14	54·9	11	< 13	..
31	— Aquarii, . . .	21	22	3	– 12	42·7	11	< 13	..
32	— Capricorni, . .	21	22	53	– 15	36·7	11	13	..
33	DM + 57°, 2568 Cephei,	22	32	16	+ 57	51·4	7·0	8·0	..
34	W Piscium, . .	23	34	6	– 1	31·6	7·5	10	..

PROVISIONAL LIST ADD

No.	Star.	R.A., 1890.0			Decl. 1890.0		Change of Magnitude.		Mean Period — Days.
							Max.	Min.	
		H.	M.	S.	°	′			
4*a*	DM + 3°, 766 Orionis,	5	0	14	+ 3	57·2	9·2 ?	< 11	?
4*b*	B. 121 Tauri, . .	5	39	6	+ 20	38·4	7 ?	8 ?	?
4*c*	DM + 68°, 398 Cameli	(5	25	22	+ 68	42·5)	8·2 ?	9·3 ?	?
14*a*	DM + 40°, 2694, .	13	44	14	+ 40	5·3	7·3 ?	9·2 ?	?
14*b*	DM + 40°, 2701, .	13	47	6	+ 40	13·3	6 ?	?	?

...te of Max.	Date of Min.	Discoverer.	Colour.	Spectrum.
..	..	Espin, 1885.	Red.	—
..	..	Espin. 1888.	Orange red.	Not continuous.
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Borelly, 1885.	—	—
..	..	Espin.	Orange red.	—
..	..	Argelander, 1869.	—	—

...HE PRESS.

Date of Max.	Date of Min.	Discoverer.	Colour.	Spectrum.
..	..	Boss, 1887.	—	—
..	..	Birmingham, 1876.	—	—
..	..	Espin, 1887.	—	Position for 1885.0
..	..	Espin, 1888.	—	III *a* ! !
..	..	Espin, 1885.	—	—

NOTES.

No. 0*a* Lalande 405 Ceti.—The variability of this star was discovered by Chandler and confirmed by Sawyer. From observations, 1883, August 25, to 1884, January 21, Sawyer finds that the variation is of the type of R Scuti.

No. 2. R Andromedæ.—Maxima were observed by Schmidt, 1882, October 28 (mag. 6·7), and 1883, December 15 (mag. 7), Sawyer observed a maximum, 1883, December 1 (mag. 6·9), and 1885, January 10 (6·6 m.). It has a remarkable spectrum of the third type, but with irregularities in the relative intensity of the bands (Dunér).

No. 6 *a* Cassiopeiæ.—Sawyer found the light constant between August 1 and December 30, 1884; January 10, to March 5, 1885; and from August 6, 1885, to January 1, 1886.

No. 6*a*. Nova Andromedæ.—The star suddenly made its appearance in August, 1885, close to the nucleus of the great nebula in Andromeda (31 Messier). It was not visible to Tempel at the Florence Observatory on August 15 and 16, but is said to have been seen by M. Ludovic Gully on August 17. It was, however, certainly seen by Mr. I. W. Ward, at Belfast, on August 19, at 11 p.m., when he estimated it 9½ m.; and independently by the Baroness de Podmaniczky, on August 22; by M. Lajoye, on August 30; by Dr. Hartwig, at Dorpat, on August 31; and by Mr. G. T. Davis at Theale, near Reading, on September 1. On September 3 the star was estimated as 7½ m., at Dun Echt, by Lord Crawford and Dr. Copeland, and its spectrum was found to be "fairly continuous." On September 4, Mr. Maunder, at the Greenwich Observatory, found the spectrum "of precisely the same character as that of the nebula, *i.e.* it was perfectly continuous, no lines either bright or dark being visible, and the red end was wanting." Dr. Huggins, however, on September 9, found three to five bright lines between D and *d* in its spectrum, a continuous spectrum being visible from D to F. The star gradually diminished in brightness; on December 10, 1885, it was estimated 14 m. at the Radcliffe Observatory, Oxford; and on February 7, 1886, it had faded to the 16th magnitude, as observed with the 26-inch refractor of the Washington Observatory. A series of measures of the *Nova* made by Professor Asaph Hall from 1885, September 29, to 1886, February 7, gave no certain indication of any parallax.

No. 6*b*. V CASSIOPEIÆ = DM 47°, 194. Observed 8·5 m. by Espin, 1886, November 30; on February 6, 1887, it was only 9·9; on February 20, 11·0, and on March 13 it had faded to 13·0 m. The variability has been confirmed by Baxendell.

No. 7. U CEPHEI.—Minima of this remarkable variable were observed by Baxendell, 1885, March 9, $9^h 43^m·5$ (9·4 m.); and 1885, August 3, $11^h 53^m·5$ (9·3 m.); by Baxendell, junior, 1885, August 3, $11^h 51^m$ (9·3m.); and by Knott, 1885, March 14, $9^h 32^m$ G.M.T., and March 19, $9^h 12^m$ G.M.T.

No. 9*a*. — PISCIUM.—Found to be variable by C. H. F. Peters, from observations at Clinton, U.S.A. (1879–1880); he found it 10 m. on January 5, 1880, but on other occasions much fainter, and sometimes invisible Later observations gave a period of 330 or $\frac{330}{n}$ days.

No. 11. R PISCIUM.—Dunér and Vogel find a spectrum of the third type with very large and dark bands. Maxima were observed by Schmidt, 1881, December 18 (mag. 7); 1882, December 5·3 (mag. 8), (*Ast. Nach.*, 2491); and 1883, Nov., 17·5) (mag. 7·5). (*A. N.*, 2577).

No. 13. R ARIETIS.—Maxima were observed by Baxendell, 1884, August 3 (mag. 8·1), and 1885, February 3 (mag. 9·0), "the lowest maximum magnitude" he had ever observed in this star. (*Observatory*, April, 1886.)

No. 14. *o* (MIRA) CETI.—The following are observed maxima since 1882:—

Year.	Date of Max.	Brightness.	Observer.	Remarks.
1884	March 6 (?),	4·6	Sawyer,	1 or 2 steps brighter than λ Ceti.
1885	February 4,	2·7	Gore,	
1885	February 10,	2·7	Sawyer,	4 steps less than α Ceti.
1885	February 11,	2·9	Knott,	
1885	February 14,	2·6	Baxendell,	
1885	December 22,	4·9	Gore.	
1885	December 29 to Jan. 13, 1886,	4·5	Numsen.	
1886	November 20 (?),	4·3	Gore.	
1886	November 30,	4·05	Markwick.	
1886	December 30,	4·4	Sawyer.	

Schmidt observed a minimum, 1883, November 28, "Helle sehr wenig geringer als die Nachbarsterne." Period since last minimum 347 ± days. (*A. N.*, 2577).

No. 15. S Persei.—The maximum given in the Catalogue was observed by the Rev. J. Hagen, s.j. (U. S. A.), mag. 7·6 (*private letter*).

No. 16*a*. U Ceti.—A variable, discovered by Sawyer on the night of December 16, 1884, when it was 7·0 m.; on January 10, 1885, it had faded to 8 m.; on February 10, to 9 m.; and on March 5, 1884, it was only 10½ m. It rose to another maximum in 1886. The star is evidently an interesting variable.

No. 17. T Arietis.—Dunér finds a spectrum of the third type, with enormously large and dark bands in the green-blue.

No. 18. ρ Persei.—Dunér calls the spectrum "superbe." Sawyer found the light nearly constant during the year 1884, and with only slight fluctuations from August 15, 1885, to January, 1886.

No. 19. β Persei (Algol).—A minimum was observed by Sawyer, 1885, December 24, $7^h 21^m$. Cambridge (U. S. A.), M. T.

No. 20. R Persei.—Maxima were observed by Schmidt, 1883, January 20 (mag. 8·2); 1883, August 27·0 (mag. 8·5); and by Baxendell, 1884, March 5 (mag. 7·9); and October 6 (mag. 7·9); and "an unusually high maximum" of 7·7 m. on December 6, 1885. He finds that the period is subject to slow changes, and deduces from 8 maxima a period of 210·06 days, with Epoch, 1870, May 16·48, and he finds that "during the last twenty years a very sensible increase in the length of the period has taken place." (*Proceedings*, L. A. S., Session 1883–84.)

No. 22*a*. — Tauri.—A star observed by Dr. Möller and Professor Vogel on the night of February 24, 1880. Spectrum III a, "Farbe röthlich Gelb, geschätzt, 9^m·2, fehlt bei Argelander." Espin could not find the star with 17½-inch reflector, September 14 and 30, 1886; but on January 16, 1887, it was found by Gage, with the same telescope, of the 9^{th} mag.; on January 22 it was barely of the 10^{th} mag., and from February 2 to March 3 it varied irregularly from 10·0 to 8·7, according to the observations of Messrs. Baxendell, Espin, and Ward.

No. 23. R Tauri.—Maxima were observed by Schmidt, 1882, October 15 (mag. 8·3), and 1883, September 15 (mag. 8).

No. 24 *a*. R Reticuli.—Discovered in 1867, at the Madras Observatory by the Hindoo observer, Ragoonatha Chary, but not included in any Catalogue of variable stars hitherto published.

No. 29. ε Aurigæ.—Schmidt, in 1883, found the fluctuations of light very small. The maximum and minimum given in the Catalogue were observed by Sawyer, who found a variation of about ½ a magnitude in 1884. My own observations, 1875–1885, show a variation of about ½ a magnitude.

No. 30. R Leporis.—The maximum given was observed by Sawyer (mag. 5·7).

No. 32. R Aurigæ.—A maximum observed by Schmidt, 1883, January 30·0 (mag. 7·8). Increase of light quicker than the decrease. A minimum, 1883, November 3 (mag. 9·2) (*A. N.*, 2577). Espin finds that the bright bands of the spectrum are brighter as the star is on the increase, and fainter as it decreases.

No. 33. S Aurigæ.—Maximum observed by Dunér.

No. 34. S Orionis.—Maximum observed by Knott.

No. 34 *a*. 31. Orionis.—My observations from November, 1884, to February, 1887, show only a small variation—5·0 to 5·5, with apparently no regular period.

No. 35. δ Orionis.—Sawyer found the light of this star constant from January 2 to April 10, 1883, and he could not detect the "least sign of variation" from November, 1884, to February, 1885.

No. 36. T Orionis.—My observations of this star from January, 1885, to February, 1887, show a variation of about half a magnitude. It is a double star, OΣ 111.

No. 36 *a*. — Orionis.—No. 822 of Bond's Catalogue of Stars in the great nebula in Orion. It was independently discovered to be variable by Schmidt, in April, 1878, and by Common, in 1883, by means of photography. It is No. 161 of my Catalogue of Suspected Variables.

37 *a*. U ("Nova") Orionis.—Found by me with a binocular field-glass, 1885, December 13, $9^h 20^m$ (Dublin, M. T.), as a reddish star of

about 6 mag. The star is not in the *Durchmusterung* or any other Catalogue. On December 16, Dr. Copeland found its spectrum a beautiful banded one of the 3rd type, "7 dark bands being readily distinguished with the prism," and suspected the existence of bright lines. M. Wolf, however, found that the presence of bright lines was not confirmed when higher dispersive power was used. He considers that the spectrum was simply that of the well-known third type, viz.: a continuous spectrum crossed by bands, bounded by dark and sharp edges towards the violet, and shading away towards the red. He partially resolved the dark bands into lines. Dr. Copeland identified three lines in the spectrum with the edges of three bands visible in cometary spectra, and the spectrum of coal gas, but these views were disputed by Mr. Maunder. The star slowly faded, and at the beginning of July, 1886, was found by Fr. Schwab below the 12^{th} magnitude. It afterwards increased again, and rose to another maximum in December, 1886. Observations by Sawyer show a maximum of 6·6 m. on December 13, 1886. Espin finds that the bright bands of the spectrum are brighter as the star is on the increase, and fainter as it decreases. He finds a companion 10·5, 110°, 30″.

No. 38. η Geminorum.—Sawyer found its light nearly constant from November 20, 1884, to February 3, 1885. (*A. N.* 2660). In 1882 Schmidt found that the increase of light was much quicker than the decrease, and from his observations in 1883 he found—from the maxima a period of 151 days, and from the minima 135 days.

No. 38*a*. V Monocerotis.—From observations, 1884–1885, Sawyer found that "The decrease of light appeared somewhat more rapid than the increase." (*A. N.* 2660.)

No. 41. S (15) Monocerotis.—From observations, 1884–1885, Sawyer found a variation of half a magnitude. It is a double star, Σ 950.

No. 44. R Geminorum.—Knott found it rising to a maximum, 1885, May 11 (mag. 7·3). It is Lalande, 13739.

No. 46. L_2 Puppis.—Maximum observed by Stanley Williams, mag. 3·55. He finds a mean period of 136·05 days with epoch maximum = 1878, March 16·0. (*Observatory*, September, 1886.)

No. 46*a*. V Geminorum.—Knott found it rising to a maximum, 1885, April 17, mag. 10·1.

No. 47. U MONOCEROTIS.—The following maxima and minima have been observed in recent years:—

MAXIMA.

1883,	January	28,	Espin.	1884,	February	3,	Sawyer.
1883,	February	14,	Espin.	1884,	March	11,	Sawyer.
1883,	March	7,	Espin.	1885,	January	25±,	Espin.
1883,	March	13,	Sawyer.	1885,	March	5,	Sawyer.

MINIMA.

1883,	February	10,	Espin.	1884,	February	24,	Sawyer.
1883,	February	20,	Espin.	1884,	April	9,	Sawyer.
1883,	March	13,	Espin.	1885,	January	4·5,	Sawyer.
1883,	April	6,	Espin.	1885,	January	6·5,	Espin.
1883,	April	7,	Sawyer.	1885,	February	17,	Espin.
1884,	January	5,	Sawyer.				

No. 48. S CANIS MINORIS.—Dunér finds a spectrum of the third type with excessively large and dark bands, especially in the green and blue.

No. 49*a*. U CANIS MINORIS.—Minima were observed by Schmidt, 1882, December 14, mag. 12·3; and by Baxendell, 1885, April 19, mag. 13·1. (*Observatory*, April, 1886.)

No. 55. U GEMINORUM.—Knott finds periods of 71 to 126 days, and observed maxima on the following dates:—1884, January 26 and October 22; 1885, January 1 ±, and April 8·8 (9·25 mag.), double max.?; and 1885, December 6 ± ? ? The variation is from 9½ to 14½ of Argelander's scale. Professor Safarik observed maxima on the following dates:—1883, October, 24·5; 1884, January 21, May 10·4; October 21; December 24·5; and 1885, April 6·5; and Baxendell on the following dates:—1885, December 7 ±; 1886, March 9·2, and December 1·1. The interval from October 21 to December 24·5, 1884 = 64·5 days, was the shortest period of this star known to Safarik. Knott says, "Period very irregular."

No. 55 *a*. — PUPPIS.—The variability has been confirmed by Dunér.

No. 56. R CANCRI.—Schmidt observed maxima, 1882, October 5 (mag. 6·5); and 1883, October 23 (mag. 6·5), which give a period of 383 days.

No. 57. V Cancri.—Maximum observed by Sawyer, 1883, April 17, equal in brightness to DM + 18°, 1947, or about 7·7 m. (*A. N.*, 2591.)

No. 58. U Cancri.—Maximum given was observed by Knott, mag. 10·6.

No. 60. S Hydræ.—Maximum given was observed by Sawyer, mag. 8·2. (Gould, *Ast. Journal*, 155.)

No. 62 *a*. N Velorum.—Dr. Gould suspects variation in colour also. The period has not been well determined. (*Uranometria Argentina*, p. 276.)

No. 63. R Carinæ.—Maxima were observed by Tebbutt, 1880, December 16; 1881, October 21; and 1882, September 2; and minima, 1880, July 5; 1881, June 8; 1882, March 27; and 1883, February 7.

No. 64. R Leonis Minoris.—Dunér finds a spectrum of the third type, with very large and dark bands, even in the blue. Maxima were observed by Schmidt, 1882, January 26·0 (mag. 6·8); and 1883, June 29 (mag. 7).

No. 65. R Leonis.—Recently observed maxima, are as follows :—

1884,	February	5,	6·7	mag.	Sawyer.
1884,	February	13,	6·6	,,	Baxendell.
1884,	December	20,	6·0	,,	Baxendell.
1884,	December	24,	5·3	,,	Sawyer.

A minimum of 9 m. was observed by Schmidt, 1882, November 6, and that given in the Catalogue by Espin.

Treating the observed maxima from 1865, February 27, to 1884, December 20, by the method of least squares, I find the following elements:—

Epoch. max. = 1874, August 19·36 + 313·999 E.

Espin finds that the bright bands of the spectrum are brighter as the star is on the increase, and fainter as it decreases.

No. 66 *a*. — Leonis.—A *Durchmusterung* star, missed by Becker, but afterwards found, 1882, April 4, as 8·6 m. Chandler found the star invisible, with 6½-inch refractor, from end of February to middle of

April, 1883. On October 31, 1883, it was 9·5 m., "after which it decreased to 13 m. at the end of December, 1883. It remained invisible until the end of March, 1884, when it reappeared, and had increased to 9·4 by the end of June." (*Science Observer*, vol. iv., No. 11.)

No. 69 *a*. U LEONIS.—Included by Schönfeld in his provisional list. He says, "+ 14°, 2239 des Bonner Sternverzeichness, $9^{m}\cdot5$. Peters, hat den Stern früher als schwach 11^{m} gesehen; 1873, April 23, vermisst, Juli 12, wieder schwach gesehen. Seit December 30, im hiesigen Refractor unsichtbar. Die Veränderlichkeit ist wohl Sicher, aber doch die Wiederscheinung und eine genaue Positionsbestimmung abzuwarten." It is No. 310 of my Catalogue of Suspected Variables.

No. 70. U HYDRÆ = Birmingham, 242.—Dunér describes the spectrum as "d'une beauté extraordinaire." From six years, observations, 1881–1886, Espin finds the following provisional elements:—

$$\text{Max.} = 1885, \text{ December } 11\cdot78 + 194^{d}\cdot65 \text{ E},$$

and

$$\text{Min.} = \text{max.} + 107^{d} \pm.$$

No. 71. R URSÆ MAJORIS.—Maxima were observed by J. Baxendell, junior, 1884, August 31 (mag. 7·4); and 1885, July 1 ±; by Knott, 1885, June 28; and by Sawyer, 1884, August 29 (mag. 7·1); and 1885, July 1. Baxendell deduces a period of 302·22 days, with epoch 1863, December 21·7, and a variable maximum of 6·6 to 8·1. Sawyer finds the increase of light very rapid, but the decrease slow and irregular. Minima were observed by J. Baxendell, junior, 1885, March 23 (mag. 13·3); and December 29 (mag. 13·2); and by Knott, 1885, March 10 (mag. 13·2).

No. 72. η ARGÛS.—This remarkable variable still remains very faint. Tebbutt's observations in New South Wales from 1877 to 1886, show that during the period it did not rise above 7 mag., and it was estimated 7·6 m. by Finlay, in March, 1886.

72 *a* — LEONIS.—Found to be variable by Prof. C. H. F. Peters, from observations at Clinton, U.S.A., 1877 to 1880 (*A. N.*, 2360). This is No. 330 of Catalogue of Suspected Variables.

No. 74. R CRATERIS.—Sadler fails to find any variation, and Espin doubts the variability. It is a double star, *h* 1181.

No. 82. T Ursæ Majoris.—Maxima were observed by Sawyer 1883, April 19 (mag. 7·3); by J. Baxendell, junior, 1884, Octobe 15 (mag. 7·8); and 1885, July 2 (mag. 8·2); and minima 1885 March 18 (mag. 13·25); and November 28 (mag. 13·1).

No. 83. R Virginis.—Maxima were observed by Sawyer, 188 June 20 (mag. 6·9); and 1884, April 11 (mag. 7·1). I observed maximum 1886, April 9 ± (mag. 7·5). A max., Sawyer, 1887, Jun 17 ± (mag. 7·1.)

No. 85. S Ursæ Majoris.—Maxima were observed by Sawyer 1883, June 16; and 1884, September 17 (mag. 7·7); by J. Baxendell junior, 1884, September 20 (mag. 7·7); and by Knott, 1885, May (mag. 7·2); and a minimum by Knott, 1885, August 30 (mag. 12·5)

86. U Virginis.—Maxima were observed by Schmidt, 1882, Ma 11·5 (mag. 7·8); 1882, December 2 (mag. 7·7); and 1883, June 18· (mag. 7·8).

No. 89. R Hydræ.—Maxima were observed by Sawyer, 188 May 9 (mag. 4·9); by Schmidt, 1883, May 15·0; and by Sawyer 1884, July 10–30 (mag. 4·2). Dunér describes the spectrum a "d'une beauté tout a fait extraordinaire." Espin finds that th bright bands are brighter as the star is on the increase, and fainter a it decreases.

No. 91. Y Virginis.—This star was measured 5·71 mag. with th meridian photometer at Harvard.

No. 91*a*. — Virginis.—Found to be variable by Professor Peter from observations at Clinton, U.S.A., in 1879–80 (*A. N.*, 2360 Later observations give a period of about one year. This is No. 42 of Catalogue of Suspected Variables.

No. 91*b*. — Virginis.—Observed at Markree, as 11 m. 185 April 17; 9 m. on the Paris Charts (No. 43), but observed by Palis only 12·5–13 m; 1880, April 2. It was observed as 11 m. b Peters on several occasions, 1870–1880. This is No 424 of Catalogu of Suspected Variables.

No. 92. R Centauri (near β Centauri).—A bright "temporary star is recorded in the Chinese Annals as having appeared A.D. 173, be tween α and β Centauri, which may possibly have been an outbur of this variable.

No. 93 *a*. — Bootis.—This star lies near DM + 16°, 2642. The mean period given was derived by Baxendell from a discussion of 7 maxima and 4 minima. The interval from minimum to maximum is 84·5 days, and from maximum to minimum 36·9 days. (*Journal L. A. S.*, vol. III., part ii.)

No. 94. S Bootis.—The maxima and minima given in the Catalogue were observed by J. Baxendell, junior, max. mag. 9·4; min. mag. 13·6.

No. 94 *a*. DM + 39°, 2773 Bootis = Lalande 26514, called V Bootis in Pickering's list.—Dunér observed a maximum, 1885, June 1 (mag. 7·2); and minima, 1885, January 28, and October 23 (mag. 9·4); and he finds the following elements :—

Epoch max. = 1884, September 3 + 266·5 E.

Epoch min. = 1885, January 29 + 266·5 E.

Dunér finds a fine spectrum of the third type, even when the star is at a minimum.

No. 95. R Camelopardi.—The following maxima have been observed in recent years :—

1882, March	20·6	8·3	mag.	Schmidt.
1882, December	28·5	8·5	,,	Schmidt.
1883, September	13	8·0	,,	Schmidt.
1884, May	30	—	,,	Baxendell.
1885, February	18	8·2	,,	Baxendell.
1885, November	14	7·8	,,	Baxendell.

No. 96. R Bootis.—The following recent maxima have been observed :—

1882, April	28·3	7·0	mag.	Schmidt.
1882, Nov.	27	7·2	,,	Schmidt.
1883, July	5·1	6·5	,,	Schmidt.
1883, July	9	7·5	,,	Sawyer.
1884, Oct.	5	7·4	,,	Sawyer.
1885, May	13	7·8	,,	Baxendell.
1885, May	16	7·8	,,	Sawyer.

No. 96 *b*. 34 Bootis.—Schmidt deduced a period of 361 days, wi a maximum, 1876, February 24, and with remarkable anomalies the light curve. The variability was confirmed by Schwab.

No. 96 *c*. U Bootis.—Maximum and minimum given were o served by Baxendell; max. mag. 9·5. (*Observatory*, April, 1886.)

No. 98. T Trian. Australis.—Observations of this and oth southern variables are much required.

No. 103. S Coronæ.—The following maxima have been observ in recent years:—

1882,	May 10,	7·7	mag.	Schmidt.
1883,	May 1·5	7·6	,,	Schmidt.
1883,	May 3,	7·3	,,	Sawyer.
1884,	April 30,	6·6	,,	Baxendell.
1884,	May 5,	7·3	,,	Sawyer.
1885,	May 8,	7·6	,,	Baxendell.

Baxendell, from observed maxima, 1864–1884, deduces a mea period of 360·416 days, with Epoch, 1873, June 27·0. The rise fro minimum to maximum occupying about 126 days, and the fall fro maximum to minimum about 234 days. Sawyer also finds th increase of light rapid, and the decrease slow. (*A.N.*, 2591.)

No. 106 *a*. Libræ.—Period somewhat irregular, but less than on year, according to Peters (*private letter*, 1885).

No. 107. R Coronæ. Schmidt observed a minimum of 12 m. abou the middle of August, 1883 (*A. N.*, 2577); and Sawyer a minimum 7·4, 1885, October 13.

No. 108. R Serpentis—Knott observed this star at the mag. 11· on April 20, 1885.

No. 109. V Coronæ.—Maxima of this star have been observed follows:—

1878,	October 5,	Dunér.
1879,	October 12,	Schmidt.
1881,	October 3,	Schmidt.
1882,	September 16,	Schmidt.
1883,	September 24,	Chandler.
1883,	September 5,	Schmidt.
1885,	August —,	Dunér.

Chandler gives the following elements:—

Max. = 1878, October 13·3 + 359·5 E.

Dunér gives

Max. = 1878, October 21·7 + 356·52 E,

and

Min. = 1879, May 3 + 356·52 E.

No. 109 *a*. — LUPI.—Discovered to be variable at Cordoba in the course of the observations for the Cordoba Zone Catalogue.

No. 110 *a*. — LIBRÆ.—Discovered to be variable by Professor Peters, at Clinton, U.S.A., in 1885. It was observed as 8½ m. at Markree, on May 8, 1851 (*private letter*, July, 1885).

No. 114. — SCORPII.—Maximum given was observed by Schmidt, mag. 12.

No. 116. R SCORPII.—The following recent maxima have been observed:—

1882,	April	24·2,	10·0	mag.	Schmidt.
1883,	July	9,	10·1	,,	Knott.
1883,	July	11·5,	10·3	,,	Schmidt.
1885,	May	—,	—	—	Knott.
1886,	July 28,		—	—	Knott.

No. 117. S SCORPII.—Maxima were observed by Schmidt, 1882, May, 29·3 (10·5 m.); and 1883, May, 14·5 (10·5 m.)

No. 118 *a*.—OPHIUCHI.—This is Birmingham, 379; Birmingham's observations, 1873–1876, vary from 7·5 to 9–9·5. Dunér observed a maximum in 1885, about end of March.

No. 119. U HERCULIS.—A maximum was observed by Baxendell, 1885, July 14 (mag. 7·4).

No. 121. *g* (30) HERCULIS.—In 1882 Schmidt found a mean period of 91 days; Sawyer, in 1885, found periods of 59 to 75 days from observations of maxima, and about 68 days from the minima.

No. 124. — HERCULIS = DM 37°, 2771.—Dunér observed a maximum in September, 1885. He finds a spectrum of the third type with the bands strongly developed in the ultra blue, but feeble in the red.

No. 125. R Ursæ Minoris.—Safarik observed maxima on th following dates:—1883, August 1, November 26; and 1884, June December 1 (*Observatory*, November, 1885). Baxendell observed minimum, 1885, September 27.

No. 125*a*. R Draconis.—The following maxima have been ol served:—

1881,	April	22,	Schmidt.	
1882,	September	4·9,	Schmidt.	
1883,	May	8·5,	Schmidt,	(mag. 8·7).
1884.	September	5,	Sawyer.	
1885,	May	16,	Sawyer.	
1885,	December	26,	Baxendell.	
1886,	January	2,	Sawyer.	

From the above maxima I find the following elements:—

$$\text{Epoch. max.} = 1884, \text{ January } 2 + 244^d{\cdot}49\,\text{E},$$

closely, *s.f.* the variable is a 9 mag. star, Ll 30413.

No. 126. S Herculis.—The following recent maxima have bee observed:—

1882,	October	3,	7	mag.	Schmidt.
1883,	September	12·8,	7	,,	Schmidt.
1884,	July	24,	7·7	,,	Baxendell.
1885,	June	11,	6·4	,,	Baxendell.

No. 129. *a* Herculis.—In 1882 Schmidt found periods of 87 an 121 days; and in 1883, periods of 54 and 60 days.

No. 130. U Ophiuchi.—It is a double star, *h* 854, the companio being 17 m., dist. 20″·54, P = 358°·8 (Burnham). The observation of Chandler and Sawyer show a curious "stand still" in the light f some fifteen minutes shortly after the minimum (*A.N.*, 2484).

No. 131. *u* (68) Herculis.—It is a double star OΣ 328, th companion being 10·1 m. dist. 4″, P = 60°·6 (Burnham, 1878).

No. 132. Nova Serpentarii.—Sadler finds that Chacornac's st (10 m., about 2′ preceding position of Nova) is identical with 16872, the star having been misplaced in Chacornac's charts owing distortion.

No. 135. T HERCULIS.—The following maxima and minima have been observed in recent years:—

MAXIMA.

1882, August	3·9,	7·4	mag.	Schmidt.
1883, June	30,	8·2	,,	Schmidt.
1883, December	14,	7·5	,,	Schmidt.
1884, May	30,	7·4	,,	Baxendell.
{ 1885, April	28,	7·9	,,	Baxendell.
{ 1885, April	26,	8·5	,,	Sawyer.

MINIMA.

1882, October	29,	12·7	mag.	Schmidt.
1883, September	29,	12·7	,,	Schmidt.
1884, August	23,	—	—	Baxendell.
1885, July	20,	12·9	mag.	Baxendell.
1886, December	6,	—	—	Baxendell.

No. 135 *a*. — SAGITTARII.—A short-period variable discovered by Sawyer in September, 1886. The star is No 57 of Sagittarius in the *Uranometria Argentina* (Lalande, 33748). He gives the following provisional elements.

M = 1886, Sept. 24·83, Cambridge (U.S.A.), MT + 5^{d}·75 E.

Duration of increase = 1^{d}·80.

,, decrease = 3^{d}·95.

(Gould's *Ast. Journal*, No. 148.)

No. 136. T SERPENTIS.—Maxima were observed by Baxendell, 1884, October 9 (mag. 10·0); and 1885, September 14 (mag. 10·5).

No. 138 a. — SERPENTIS = DM + 8°, 3780.—A variable discovered by Espin in 1886. It is 8·6 in the *Durchmusterung*, but was found 7·7 m. by Espin, on April 26, 1886; it afterwards increased in light, and on June 8 passed a maximum of 6·8 m. It then diminished, and was estimated 8·2 by Espin, on August 20, and 8·8 on September 4. On August 22 I estimated it 8·5 with binocular; on September 30, I found it 8·8, or 9 m. Espin found it again near a maximum (6·8), 1887, March 23.

No. 140 R Scuti.—From good observations of maxima in 1882, Schmidt deduced a period of 168 days. (*A.N.*, 2491). Maxima were observed by Sawyer, 1883, June 1; 1884, June 7, August 3, October 17, and November 30 (approximate); 1885, June 17, August 10 (?), and November 16; and minima, 1884, July 12, September 15, November 11; 1885, July 14, and September 24; and 1887, November 23.

No. 142. β Lyræ.—According to Pickering's theory of short-period variables, this star is a surface of revolution, the ratio of the axes being as 5 : 3, with the dark portion at one of the ends, and symmetrically situated as regards the larger axis.

No. 143. R (13) Lyræ.—Particularly bright phases were observed by Sawyer, 1883, August 6 and 31; 1884, November 7–12, and November 21–30. "The increase of light from its normal brightness at maximum amounted to about half a magnitude." (*A.N.*, 2660). Dunér says, "Le spectre est un des plus superbes de cette classe"; and Vogel describes it as "ein vorzüglich schönes Spectrum, welches dem von α Herculis gleicht."

No. 148. R Sagittarii.—Dunér finds a spectrum of the third type with extremely large and dark bands in the green and blue, but feeble in the red.

No. 149 *a*. U Aquilæ.—A short period variable, discovered by Sawyer in 1886. It is No 50 of Aquila (= Lalande, 36791), in the *Uranometria Argentina*, where it is 7·0 mag. Lalande rated it at 6. Sawyer gives the following elements:—

Epoch. max. = 1886, September 20·01, Camb. (U.S.A.), M.T. + $7^d{\cdot}0$ E.

Duration of increase = $2^d{\cdot}5$.

,, decrease = $4^d{\cdot}5$.

(Gould's *Ast. Journal*, No. 155.)

No. 150. h_1 (51) Sagittarii.—No period seems to have been yet found for this star. Observations of this and other southern variables are much required.

No. 151. R Cygni.—Schmidt observed maxima 1882, October 13 (7 m.); and 1883, December 15 (6·8 m.); and Baxendell, 1885, February 20 (8·2 m.), and 1886, March 22. The mean period in the Catalogue was given by Schmidt. (*A.N.*, 2577.)

No. 153. S. VULPECULÆ.—The mean period given in the Catalogue was derived by J. Baxendell, jun., from a discussion of nineteen observed maxima, 1863–1885; and 20 minima, 1863–1885. The period seems to have diminished very slightly between the years 1868 and 1884, but since the latter year it has returned to its original length. The increase of light is much more rapid than the decrease, the former occupying about 20·6 days, and the latter 47·19 days. (*Observatory*, March, 1886.) Maxima were observed by Baxendell, 1885, July 1 (mag. 9·2), September 11 (mag. 9·1), and November 20 (mag. 8·9); and minima, 1885, June 12 (mag. 9·8), August 20 (mag. 9·7), and October 30 (9·75 m.), (*Observatory*, April 1886), and 1886, December 15.)

No. 154. χ CYGNI.—The maximum given in the Catalogue was observed by Sawyer, and Gore. The star was again at maximum, 1886, January 20, according to Sawyer.

No. 155 *a*. S (10) SAGITTÆ.—A short period variable, discovered by Gore in 1885. Owing to its proximity to a good comparison star —11 Sagittæ—the variation of light, although small, is very evident, and the changes are very interesting. Espin remarks that the star is about four days visible to the naked eye, and four days invisible. From a discussion of all the available observations to May, 1886, Chandler finds the following elements:—

Max. = 1885, December, $4^d\,9^h\,36^m$, Gr. M. T. + $8^d\,9^h\,11^m{\cdot}0$ (E − 391);

or, reckoned from the Julian epoch,

$$\text{Max.} = 2409880{\cdot}40.\quad \text{Gr. M. T.} + 8^d{\cdot}38264\,(E - 391).$$

$$\text{Duration of increase} = 3^d{\cdot}00.$$

$$\text{,,} \quad \text{,,} \quad \text{decrease} = 5^d{\cdot}38.$$

(*A. N.*, No. 2749.)

In the above formulæ, 391 is the number of the given epoch, reckoning from an observation by me, 1876, December 14, when the star must have been near a maximum.

No. 155 *b*. — CYGNI.—A red star, discovered by Espin, March 23, 1887, 7·5 mag. 5^s f, and 3′ south of 26 Cygni. It is not in the *Durchmusterung*, or any other Catalogue. On March 28, Baxendell estimated it 7·1 m., and on April 14 it had decreased to 8·0 m., and on May 9 to 9·2 m.

No. 156. S Cygni.—Maxima were observed by Baxendell, 1884 December 4 (mag. 10·1), and 1885, November 6 (mag. 9·5).

No. 158. S Aquilæ. — Baxendell has observed the following maxima and minima:—

Maxima.	Minima.
1884, July 11.	1884, September 11.
1884, November 25.	1884, December 21.
1885, August 18.	1885, June 10.
1885, December 25.	1885, October 2.

He finds that since the end of 1883 the period has been subject to "great and very unusual irregularities," varying from 101 to 171 days; but no material change has taken place in the mean magnitudes at maxima and minima. The light curve is also very variable. (*Observatory*, March, 1886.) A minimum was observed by Knott, 1885, June 16 (mag. 11·0).

No. 160. R Sagittæ.—Baxendell finds that the minima of this star have been "reversed" in late years, and that "the mean difference between the magnitudes at the two minima is slowly decreasing." He finds the period to vary from 69·96 to 70·98 days. Baxendell observed maxima and minima as follows:—

Maxima.			Minima.		
Principal.	Secondary.	Mag.	Principal.	Secondary.	Mag.
1885, May 8.	—	8·65.	—	1885, Jan. 8.	9·0.
—	1885, June 21.	8·75.	1885, April 27.	—	9·7.
1885, Aug. 4.	—	8·75.	—	1885, May 30.	8·95.
1885, Sept. 30.	—	8·65.	1885, Sept. 17.	—	9·9.
—	—	—	—	1885, Oct. 20.	8·9.
—	—	—	1885, Nov. 24.	—	9·9.
1886, Nov. 27.	—	—	1886, Nov. 10.	—	—

In August, when a secondary minimum was due, the light remained constant at 8·8 for a period of sixteen days. (*Observatory*, April, 1886.)

161 *a*. V CAPRICORNI.—"A fine ruby star," observed as 6½ m. by Sir John Herschel at the Cape. It is Lalande, 38839 (= AOe, 20363), and Birmingham, 545 (= Schj. 238). It was found to be variable by Secchi, in 1869; and in July, 1875, and November, 1876, I found it only 8½ m. in the Punjab, and called attention to its probable variability (*Southern Stellar Objects*, p. 107). The variability has lately been confirmed by Safarik. (*Observatory*, November, 1885.)

163. U CYGNI.—The following recent maxima have been observed:—

1884, February	1,	7·8 mag.		Knott.
1885, May	28,	7·5	,,	Baxendell.
1885, May	16,	7·65	,,	Knott.
1886, September	19,	7·5	,,	Gore.
1886. August	17 ±	—	—	Knott.

164. R CEPHEI.—Observations in 1885 by J. Baxendell, junior, show only a fluctuation of light of about two-tenths of a magnitude. (*Observatory*, April, 1886.)

165 *a*. V CYGNI.—This is the red star discovered by Birmingham, 1881, May 22, 2° 51′·7*n* of *α* Cygni. (It is No. 635 of Gore's *Catalogue of Suspected Variables*.) Herr Lindemann observed maxima, 1882, August 31 (mag. 6·8); and 1883, August 5 (mag. 7·3). Schmidt, however, found a maximum on July 17, 1882 (mag. below 7); and Safarik, on June 17, 1882. A maximum was observed by Baxendell, 1885, December 30 (mag. 9·5); and a minimum, 1885, May 31 (mag. 13·2); at this minimum the star remained "unchanged for a period of four months." (*Observatory*, April, 1886.) Espin gives period = 440^d ±, with mean epoch, 1886, January 1.

166. S DELPHINI. (Baxendell's R Delphini.)—The maximum and minimum given were observed by Baxendell: maximum, 9·0 mag.; minimum, 11·1 mag. Baxendell, another min., 1886, December 12.

166 *a*. — CYGNI. (Lalande 40083).—A short period variable, discovered by Chandler in November, 1886. He gives the following elements:—

1886, October 13^d 14^h 20^m, Cambridge (U. S. A.) M. T. + 15^d 14^h 24^m E.

"The increase of light occupies about four days; the decrease, ten days, with a halt in the latter about midway of its course." (Gould's *Ast. Journal*, No. 148.)

167. T Delphini. (Baxendell's S Delphini.)—Schmidt observed maximum, 1883, October 1 (mag. 8·4). Baxendell observed a maximum, 1885, August 8 (mag. 10·1)—the lowest maximum mag. he ha ever observed. A maximum was observed by Knott, 1885, August 1 (mag. 10·3); and by Baxendell, 1886, July 1.

167 *a.* — Delphini = DM 17°, 4401 = Birmingham, 569.—Variatio discovered by Espin, and confirmed by Gore. It was rated 6·8 m. b Argelander; 8 m. by d'Arrest, 1874, September 10. Not in Lalande' *Catalogue;* 8 m., Harding; 6–7, Heis. Variation was suspected b d'Arrest. Espin estimated it 7·5, on June 28, 1884; and 6·3, o July 23. My observations from September, 1884, to January, 188 (66 in number), show a variation from 6·4 m. to 7·3 m., with maxima 1884, December 14, and 1885, November 9 ± ; and minima, about 1884 October 22; 1885, September 30, December 28; and 1886, August 29 ±, with a period of perhaps 111 ± days.

169. T Cygni.—Sawyer found the variation very small in the year 1884. Burnham found a 12 mag. companion at 10″ distant.

170 *a.* — Vulpeculæ = DM + 27°, 3890.—An interesting variable of short period, discovered by Sawyer. The star lies closely *np* 32 Vulpeculæ. From observations in 1885–6, Chandler finds the following elements:—

Max. = 1885, November, 2·8576 G. M. T. + $4^{d}\cdot4368$ E.

The duration of increase is 1·060 days, and that of decrease, 3·377 days.

No. 170 *b.* — Cygni.—A variable of the rare type of Algol, discovered by Chandler, in 1886, while using it as a comparison star for No. 166 *a.* He gives the following elements:—

Min. = 1886, Dec. $9^{d}\ 6^{h}\ 22^{m}$, Cambridge (U. S. A.) M. T. + $2^{d}\ 23^{h}\ 56^{m}\cdot 0$.

(Gould's *Astronomical Journal*, No. 150).

No. 171. R Vulpeculæ.—Knott observed a maximum of 8·2 m. on July 20, 1885, or forty-seven days later than the calculated date of maximum.

No. 173. — Capricorni.—This star lies 9½′ due south of χ (25) Capricorni.

No. 174. 63 Cygni.—Pickering considers the variability of this star doubtful.

No. 175. T CEPHEI.—From four observed maxima, 1882–1885, Knott deduces a period of 392·0 days with Epoch 1884, March 6; and from 5 minima, 1881–1885, a period of 385·4 days with Epoch 1883, August 7. The elements derived from the maxima give much smaller residuals than those derived from the minima. The increase of light is slower than the decrease. "The star has a fine spectrum, with dark bands of considerable intensity. The following maxima and minima were observed by Knott:—

Maxima.			Minima.		
1882, January	13,	6·4 mag.	1881, June	18,	9·5 mag.
1883, February	6,	6·3 „	1882, July	23,	9·8 „
1884, March	7,	6·7 „	1883, August	23,	9·9 „
1885, April	2,	6·3 „	1884, August	15,	9·7 „
1886, March	26 ±	— —	1885, September	15,	9·6 „
1887, March	26	— —	1886, October	16,	— —
			1887, November	14,	— —

My observations in 1886 show a maximum about April 21 ±, mag. about 5·7.

The star is indentical with DM + 67°, 1291.

No. 176 *a*. W CYGNI (= DM + 44°, 3877 = Lalande, 42153).—This is No. 587 of Birmingham's *Catalogue of Red Stars*. I detected variation in this star in September, 1884. The extremes of variation seem to be from 5·8 at maximum to about 7·3 at minimum, with a period of 120 to 130 days. The following maxima and minima have been observed:—

MAXIMA.

1884, December	23,	5·8 mag.	Gore.
1885, August	19,	6·0 „	Gore.
1885, August	20,	6·1 „	Sawyer.
1885, December	16,	6·1 „	Sawyer.
1885, December	16,	6·2 „	Gore.
1886, May	19,	5·8 „	Gore.
1887, February	5 ±,	6·0 „	Gore.
1887, Sept.	16 ±,	— —	Gore.

MINIMA.

1885, June	9,	7·3 mag.	Gore.
1885, October	22,	6·8 „	Gore.
1885, October	30,	6·7 „	Sawyer
1886, February	14,	7·0 „	Gore

Sawyer finds that "the light curve exhibits a rather rapid and uniform increase, with a somewhat less rapid and irregular decrease. Its red colour render it rather a difficult object to observe."

No. 179. μ Cephei.—I have 167 observations of this star from March, 1883, to March, 1888. These show a variation of light of a little more than one magnitude, but with no regular period. Owing to its red colour, and occasionally strong scintillation, it is a rather difficult object to observe. The spectrum is a most perfect one of the third type, according to d'Arrest, the separating spaces being sharp, dark, and very broad. Dunér finds, however, that the bands, although dark, are not very large. The maximum and minimum given in the Catalogue were observed by me.

179 *a*. — Aquarii.—The period given was found by Peters (*private letter*, July, 1885).

No. 180 *a*. R (?) Piscis Australis.—Found to be variable at Cordoba during the course of the observations for the *Cordoba Zone Catalogue*.

No. 181 *a*. R Indi.—Found to be variable at Cordoba during the course of the observations for the *Cordoba Zone Catalogue*.

No. 182 *a*. R Lacertæ.—The maximum given was observed by Deichmüller. (*A. N.*, 2493.)

No. 184. β Pegasi.—In 1883 Schmidt found a mean period of 29·7 days. Observations by Sawyer from August 1, 1884, to January, 1885, showed only slight fluctuations of light of "not more than a couple of steps"; and from Jan. 10 to February 3, 1885; and July 15, 1885, to January 1, 1886, he found the light "apparently constant."

No. 185. R Pegasi.—Maximum observed by Schmidt.

No. 187. R Aquarii.—The maximum given was observed by Sawyer, mag. 7·1

No. 187 *a*. 19 Piscium.—From observations of this red star, 1881–1884, Espin finds the following provisional elements:—

$$\text{Epoch. max.} = 1884, \text{ August } 19 + 165^{d} \pm.$$

Espin finds the star orange at maximum and orange-red at minimum. My observations confirm the variability.

Dunér finds a "Superbe" spectrum with large strong bands. Vogel's observations agree with Dunér's in all essential details.

No. 187 *b*. — PHŒNICIS.—Found to be variable at Cordoba during the course of the observations for the *Cordoba Zone Catalogue*.

189. R CASSIOPEIÆ.—Schönfeld's formula (max. = 1866 – 4 – 18·9 + $425^d \cdot 9$ E – $0^d \cdot 40$ E^2) does not represent observations in recent years. The following maxima have been observed:—

1879, February	20,	scarcely 7 mag.		Schmidt.
1880, May	18,	6·8	,,	Schmidt.
1881, July	14·5,	—	—	Schmidt.
1882, September	3·5,	about $6 \cdot 5^m$ mag.		Schmidt.
1882, October	4,	secondary max.		Schmidt.
1883, November	21,	$6 \cdot 6^m$	,,	Schmidt.
1885, February	6,	$6 \cdot 1^m$	,,	Baxendell.
1886, April	14 ±	$5 \cdot 6^m$	,,	Gore.

Treating the above by the method of least squares, I find the following provisional elements:—

$$\text{Max.} = 1882, \text{ September } 18 + 433 \cdot 41 \text{ E.}$$

No. 190. U CASSIOPEIÆ.—Observations of this star are much required.

NOTES TO PROVISIONAL LIST.

No. 1. PISCIUM.—Announced as variable by Borelly in 1885 (*Bulletin Astronomique*, tom. II., pp. 61–63). My observations, September to December, 1886, show a star 8½–9 m. close to Borelly's position.

No. 2. LALANDE 2598 CETI.—Dr. Gould says, "this is certainly variable." The Cordoba estimates vary from 6·5 to 7·8.

No. 3. 100 PISCIUM.—Announced as variable by Borelly in 1885. My observations from September, 1885, to December, 1886, show a small variation of about 0·3 m. Observations by Markwick, November, 1886, to January, 1887, vary from 7·4 to 7·8. It is a double star Σ 136, 6·9, 7·8 : 79°·2 : 16″·4, and has a considerable proper motion.

No. 4. LALANDE 7172 TAURI.—The Cordoba estimates of this star vary from 6·8 to 7·9, and the star is probably variable. In a few observations in November and December, 1884, and February and November, 1885, I found it 8 to 8·2 m. Markwick estimated it 7·8 m. on January 12, 1887, and 7·4 on February 12.

No. 5. π PUPPIS.—Variation has been suspected in this brigh southern star; and observations by Stanley Williams, in 1886, seen to confirm the variability.

No. 6. U PUPPIS = Ll 14551.—Announced by Espin as variabl in 1883; and the variation was apparently confirmed by observation made by Mr. W. E. Jackson, which indicate a period of about fourtee days. (*Journal L. A. S.*, vol. III., part ii.) Sawyer, however, fail to find any variation; and a few observations I made of the star i March, 1886, show no fluctuation.

No. 7. LACAILLE 3105 PUPPIS.—Observations by Stanley Williams in 1886, seem to show a small variation in a period of about 4·2 days (*M. Not. R. A. S.*, January, 1887.)

No. 8. R PYXIDIS.—Found to be variable at Cordoba, but period undetermined.

No. 9. — CANCRI = DM + 11°, 1954.—Near the star cluster, 67 Messier; observations by Baxendell, April, 1860, to March, 1862, show a variation of about one magnitude. It is of a ruddy colour. Declination given is, according to Baxendell, "perhaps about 1′ too little" (*private letter*, May 1885).

No. 10. 74 CANCRI.—Announced as variable by Borelly, in 1885, but variation not yet confirmed by any other observer.

No. 11. — SEXTANTIS.—Announced as variable by Borelly, in 1885. On March 3 and 13, 1886, I found the star below 8 m.; but on the following dates: 1886, March 26, April 21, May 21; and 1887, March 29, April 12, 16, 18, 24, it was not visible with the binocular in a clear moonless sky.

No. 12. — LEONIS.—Announced as variable by Borelly, in 1885.

No. 13. BIRMINGHAM 277 VIRGINIS.—This is No. 367 of *Catalogue of Suspected Variable Stars*, and seems most probably variable. It was estimated 8·8 mag. by Espin, 1885, May 12; and 7 mag. by Gemmill, 1886, November 17 and 29.

No. 14. BIRMINGHAM 290 CANES VENAT.—This is No. 383 of *Catalogue of Suspected Variables*, and seems most probably variable.

No. 15. LACAILLE 6077 APODIS.—No. 452 of *Catalogue of Suspected Variables*. Dr. Gould seems to think the variation certain.

No. 17. — Libræ = Lalande 28607.—No. 476 of *Catalogue of Suspected Variables.*

No. 19. Lacaille 7646 Sagittarii.—No. 544 of *Catalogue of Suspected Variables.* Found to be variable at Cordoba, but the observations are discordant, owing to the apparent variability of several of the comparison stars (*U. A.*, p. 288).

No. 20. B 535 Cygni = DM 47°, 3031.—Espin observed a minimum about end of April, 1886. On May 11 it was 8·9 m., and on August 22 it had increased to 7·7 m.

No. 21. DM + 35°, 4002 Cygni, 10 m., Pickering, 1880, but observed as 8·5 m., and very red, by Espin, June 26, 1886; but only 9·5 m. on August 29, 1886.

No. 2?. B 541 Cygni = DM + 38°, 3957.—From observations, 1885-1887, Espin finds variation from 7·2 to 8·2. It is the southern star of a wide pair.

No. 24. ρ Capricorni.—Announced as variable by Borelly in 1885. It was rated 6 m. by Lalande, 5–6 by Heis, 5·3 at Cordoba, and 4·98 at Harvard. From my own observations I had previously suspected variation in π Capricorni, which lies close to ρ (π is No. 624 of *Catalogue of Suspected Variables*).

No. 25. Anon Capricorni.—I have always found this star below 8 mag.

No. 26. DM + 39°, 4208 Cygni.—Found by Espin, 1885, July 9, as a splendid red star, mag. 7·9, afterwards diminishing to 9·2; no period found. Espin found it below 8 m., 1885, August 13, September 7, and September 9.

No. 27. — Capricorni = Lalande 40866.—Announced as variable by Borelly in 1885.

No. 34. DM + 57°, 2568 Cephei.—A fine orange-red star, found by Espin. Variation observed from 7·0 to 8·0, with probably a short period.

No. 34. W Piscium.—This star is not in Lalande's *Catalogue*, or Harding's *Atlas*.

NOTES ADDED IN THE PRESS.

No. 7. U Cephei.—Knott's period is 2·492857 days. Schmid gave 2·492886 days. (*Observatory*, December, 1880.) A minimun was observed 1887, February 25, $8^h\ 34^m\ 5^s$.

No. 33. S Aurigæ.—Maxima were observed by Dunér, 1885 February 12; and 1886, March 7 (mag. 9·5). "Variation irregular, o law very complicated."

No. 37. α Orionis (Betelgeuse).—A well-marked minimun occurred about the middle of December, 1887.

No. 37 *a*. U ("Nova") Orionis.—This star rose to another maximun in December, 1887, but did not much exceed 7·5 magnitude at thi maximum.

No. 39. T Monocerotis.—Sawyer observed the following maxim and minima in 1887–88. (Gould's *Ast. Journal*, No. 174.)

Observed Maxima.

1887, November 29, $16^h\ 50^m$.	1888, February 20, $10^h\ 18^m$.
1887, December 27, $10^h\ 53^m$.	1888, March 17, $12^h\ 2^m$.
1888, January 23, $9^h\ 55^m$.	1888, April 13, $23^h\ 51^m$.

Observed Minima.

1887, November 20, $2^h\ 18^m$.	1888, February 9, $9^h\ 31^m$.
1887, December 20, $7^h\ 16^m$.	1888, March 6, $8^h\ 48^m$.
1888, January 14, $19^h\ 10^m$.	1888, April 4, $3^h\ 3^m$.

No. 41. S (15) Monocerotis.—A distant companion at 139°·2 : 75″· has been suspected of variation, as it was estimated 8·5 by Mai (1863·16), and only 12 m. by Sadler (1875·3). Tarrant's observatior in March and April, 1888, show it to be certainly variable to th extent of at least 1½ mag. This object deserves careful attentior as a variable companion to a known variable star is very rare, if n an unique phenomenon.

No. 46 A. R CANIS MAJORIS.—A variable of the Algol type, discovered by Sawyer in 1887. His observations in March and April, 1887, show that "the period is some aliquot part of eight days," probably $1^d\ 3^h \pm$.

No. 46 a V GEMINORUM.—Knott finds the elements:—

$$\text{Max.} = 1882, \text{May } 14{\cdot}6 + 276^d\ 5^h\ E.$$

No. 71. R URSÆ MAJORIS.—Maxima were observed 1886, May 1 (Baxendell, jun.); 1886, April 29 (Sawyer); and 1887, February 21 (Knott); and minima, 1886, November 20 (Baxendell, jun.), and 1877, September 13.

No. 72. η ARGUS.—In May, 1888, Tebbutt found that this remarkable star "had increased fully half a magnitude" in light since April, 1887, and "it may now be rated as a star of the 7·0 magnitude." (*Observatory*, July, 1888.)

No. 82. T URSÆ MAJORIS.—Maxima were observed by Sawyer, 1884, October 17 (7·8 m.); and 1885, June 22 (8·5 mag.); and by J. Baxendell, jun., 1886, November 17.

No. 83. R VIRGINIS.—Maxima were observed by Sawyer, 1885, June 13 (7·0 m.); and 1886, April 8.

No. 85. S URSÆ MAJORIS.—The following maxima and minima have been observed in recent years:—

MAXIMA.

{ 1885,	May	7,	J. Baxendell, jun.
{ 1885,	May	7,	Sawyer.
{ 1885,	December	25,	J. Baxendell, jun.
{ 1885,	December	25,	Knott.
1886,	August	10,	Knott.
1887,	March	13,	Knott.
1887,	November	1 ±,	—

MINIMA.

1885,	June	16 (12·2 m.),	J. Baxendell, jun.
1885,	August	28 (12·8 m.),	J. Baxendell, jun.
{ 1885,	December	2,	Knott.
{ 1886,	December	8,	J. Baxendell, jun.
1887,	July	11,	Knott.

No. 103. S Coronæ.—Maxima were observed by Baxendell, 1886 April 28; and by Sawyer, 1885, May 11; 1886, May 10; and 1887 April 19 (mag. 7·1).

No. 121. g (30) Herculis.—From observations in 1887, Sawyer finds periods of 62–86 days.

No. 130. U Ophiuchi.—Chandler gives the following elements:—

$$\text{Min.} = 1884, \text{January } 1, 0^h\ 54^m\ 43^s\cdot 6 \ (\text{Paris, M.T.})$$

$$+ 20^h\ 7^m\ 41^s\cdot 6\ (E - 1070) - 0^s\cdot 0002\ E^2.$$

(Gould's *Astronomical Journal*, Nos. 161 and 162).

No. 138 *a*. — Serpentis = DM + 8°, 3780.—The following maxima have been observed by Espin:—1886, June 8; 1887, April 14; and 1888, February 18.

No. 153. S Vulpeculæ.—The maximum and minimum given in the Catalogue were observed by Baxendell.

No. 155 *a*. S(10) Sagittæ.—Sawyer finds a correction to Chandler's epoch of maximum of $-0^d\cdot 29$, and to the period a correction of $-0^m\cdot 96$.

No. 155 *b*. — Cygni.—In May, 1888, Espin found this star below 13 mag., and showing no signs of increasing in light.

No. 156. S Cygni.—The maximum given in the Catalogue was observed by Knott.

No. 158. S Aquilæ.—The maximum and minimum given in the Catalogue were observed by Knott.

No. 170 *b*. — Cygni.—The period of this Algol star has now been proved to be $1^d\ 12^h \pm$.

No. 175. T Cephei.—Treating Mr. Knott's observations of minima by the method of least squares, I find the following provisional elements:—

Epoch minimum = 1884, August 29·5 + 387·92 E.

No. 176*a*. W CYGNI.—Sawyer has observed the following additional maxima and minima:—

MAXIMA.	MINIMA.
1887, September 13 (6·1 m.).	1887, July 23 (6·7 m.).
1888, January 20 (6·2 m.).	1887, December 8 (6·7 m.).

He finds the period in 1887, 138 days.

NOTES ADDED IN PRESS TO PROVISIONAL LIST.

No. 5. π PUPPIS.—Stanley Williams says (*Astronomical Register*, October, 1886):—"This beautifully coloured star is No. 171 of Birmingham's *Catalogue of Red Stars*, having been noted red by Schmidt. Herschel, with the 20 ft. reflector, only called it yellow; and in the U.A. it is only marked with a single *r*. Gore, in 1875, found the large star a beautiful orange, and in the end of 1885 and commencement of 1886 it was certainly one of the finest orange stars in the heavens. It would seem from this that there is a strong probability of variation in colour. It has also been suspected to vary in brightness, and my observations made on about thirty nights in 1885–6 confirm this, the determinations varying from 2·3 to 3·3. This star may, therefore, now be placed on the list of known variable stars."

No. 11. — SEXTANTIS.—This star lies a little *s. f.* DM + 7°, 2181 (6·3 m.), Gould, and about 11′ south of Lalande, 19207 (8½). It is not in Lalande's *Catalogue* or Harding's *Atlas*.

No. 12*a*. Lalande, 20918, HYDRÆ.—6½ Lalande; 6 m. Argelander; 7 m. Tacchini (1868·309); estimated 7·3 at Cordoba, 1871, July 6, and 8 m. in May, 1877, but found only 9 m. by Chandler, 1888, April. This star evidently requires careful observation. Dr. Gould calls it "very red." (*Uranometria Argentina*, pp. 303, 304). It is Birmingham 248, and is No. 329 of my *Catalogue of Suspected Variable Stars*. It is one of the reddest stars in the heavens.

No. 14*a*. DM + 40°, 2694.—9·2 mag. in DM, but observed b Espin as 7·3, 1888, April 6, and 7·7 on April 8. "The spectroscop shows a fine III type spectrum." The star is not in Lalande o Weisse's Bessel.

No. 26*a*. Anon. Cygni.—A red star, not in *Durchmusterung*, foun by Espin, 1888, May 8, and estimated 8·1 mag. "The spectrum i not continuous."

No. 33. DM + 57°, 2568 Cephei.—A fine orange-red star, foun by Espin, who thinks it variable from 7·0 to 8·0, with probably a shor period.

XIV.

MODERN MATHEMATICS. By R. A. ROBERTS, M.A., Trinity College, Dublin.

[Read November 8, 1886.]

There have been such vast strides made in mathematical knowledge in this century, and especially in the latter half of it, that it is much easier now than heretofore to form an opinion as to the position of mathematics. From this great extension of mathematics, we can now more exactly assign the points where it touches on other subjects, and its relative position among the different branches of human knowledge. And from the internal point of view, we can now more readily classify all the various divisions and subdivisions, and are thus enabled to enumerate all the principal results which have been obtained, and form some idea as to where something remains still to be done.

In opening any mathematical treatise of the last century or beginning of the present, and another belonging to the modern school, we are at once struck by the great difference in the appearance of the mathematical work. We see new notations, old ones greatly altered, and a number of new words arising from the growth of new mathematical ideas. In fact, we see a complete transformation effected in the whole nature of the subject. This is due to the modern mathematical idea. The first recognition of the modern idea was on the geometrical side, and is to be found in Poncelet's *Treatise on Projective Properties*, published in 1822. Afterwards, on the algebraic side, Boole first came upon the germs of the theory of invariants, but did not seem to perceive its importance. It was then Cayley took up this branch of the subject, grasped the idea in all its entirety, and worked it out to its fullest extent, thus laying the foundation of the present great structure of mathematical knowledge, and opening up a wide field of labour for the mathematicians of the future.

In the days of Newton, Leibnitz, Euler, and others, mathematics was a vast unexplored world. In whatever direction investigations were made, the searcher was constantly rewarded by discoveries,

which, perhaps, often gave more pleasure from the fact that they w unexpected and came as surprises. The mathematicians of those d resembled the ocean navigators, Columbus, Magellan, Vasco de Gan and others of the same period, who went forth over the world discover new lands. And as these, while bent on some particu object, often, unexpectedly, made great discoveries, so the matl maticians referred to came upon important theorems in mathemat in the course of their investigations of geometrical and physi problems. And in the same way as the whole extent of the earth known now, so also is the whole range of mathematics mapped o and its various departments have their boundaries assigned. Al like our physical world, the regions are mapped out, though the great part yet remains unoccupied: and that part awaits being opened and brought within the domain of cultivated territory; and, li many districts of the earth which for a long time were believed to barren and uninhabitable, and have now proved to be quite t contrary, there are branches of mathematics neglected, and heretofo believed to be unproductive, which may turn out to be most ferti and yield many results in the future to the investigator.

But in this comparison the similitude only holds up to a certai point. The earth is finite, and when we have occupied and exhauste it, nothing more remains to be done; but there is no limit to th acquisition of mathematical knowledge. In fact, in mathematics w can move from one planet to another, and when we have exhauste one solar system, we can take wings and seek another, where we ma find a fresh field for investigation.

In the old-fashioned method of proceeding to solve problems, th same process was gone through over and over again, the mathematica worker being apparently unconscious that he had ever done anythin like it before. For instance, in finding the envelope of a system c curves or surfaces varying, subject to certain conditions, the sam process was continually repeated, and the fact that such problem depended upon finding the discriminant of an algebraic equatio seemed to be unknown. Also, the determination of the discriminan of every algebraic equation that turned up in the consideration of an geometrical problem was treated as a separate question and not as on of a class. In this direction the change brought about by the opera tion of the modern mathematical idea has been most striking. How ever, this could hardly have been otherwise. In the days of thes earlier mathematicians, the starting-point was immediately fron experience. All the problems in mathematics had their origin i

physics and geometry, and the modern mathematical conceptions could of course be hardly perceived, or have any attention paid to them by those who considered these subjects exclusively as their object.

In these earlier times the study of mathematics, perhaps, afforded more pleasure than it does now, because new discoveries were more easily made, and with a less extent of reading. Now, no doubt, the methods of attacking questions are both more numerous and more powerful; but it is necessary to read, and hold together in the mind, the greater part of what has been previously done in a subject, before we can attempt to discover any new results. Still, however, it is remarkable how many new and interesting theorems can be obtained when we plough a narrow field such as the geometry of circles and triangles.

The modern mathematical idea consists chiefly in the theory of projection, combined with the principle of continuity, and the recognition of the fact that angles and lengths in the Euclidian geometry of experience depend upon a certain absolute curve of the second degree. On the algebraic side it has developed the theory of linear transformations and invariants, to which we may add the recognition of the value of homogeneity, and the symmetry derived therefrom. These principles have been only applied later on in the transcendental analysis; but it is evident what advantages are obtained by keeping in their general form the quantities involved in elliptic and hyper-elliptic integrals, as we are enabled thence by symmetry to write down several formulæ by interchanging the roots. Also, in the theory of elliptic integrals, it may be observed that we have a decided gain in symmetry by considering the functions sn, cn, dn as the ratios of four functions, the absolute magnitudes of which are, and remain, indeterminate.

In the other branches of mathematics, such as the theory of Differential Equations, the modern methods do not appear to have effected so much progress. This is, no doubt, partly due to the nature of the subject. In fact, it is evident that before we can proceed much further in the solution of differential equations, we must have a more complete knowledge of the various functions which are introduced to our notice by the Integral Calculus. However, it may be admitted that we cannot expect any systematic and regular progress in the Theory of Differential Equations until the modern methods are applied at least to some extent. This has at length been done in a very complete and suggestive manner by Professor Sylvester in his idea of "Reciprocants;" so that now, the attention of mathematicians being turned in this direction, we may hope for the opening up of a large

field of discovery in an important branch of mathematical knowledge.

When we have got a clear view of the modern mathematical idea we are enabled thereby to dispense to a great extent with long calculations, which after all only serve to obscure the view, and prevent us from obtaining an insight into the relations connecting quantities. The modern mathematical idea gives us the power to hold together in the mind a large extent of knowledge, and perceive the connexion and mutual interdependence of the different departments of that knowledge. We are thus enabled to predict, or at least form, an opinion of some value as to the result of certain transformations, and hence we can avoid a large amount of useless labour, and direct our attention to those points which are most likely to repay a careful study. This power is evidently of much more value than the ability to make long investigations, or fill pages with work, the faculty of correct working being easily attained by the force of habit, and not appearing to differ essentially from that of performing complicated sums in commercial matters. On looking back through the vast tomes of work written on mathematical subjects, especially on the physical side, during the preceding century, we see a great number of investigations commenced, which lead to practically no result. We see, thus, the importance of being able to direct, both in pure and mixed mathematics, our steps into those paths which are most likely to lead to valuable results. Of course there is naturally an indisposition on the part of many mathematical workers to destroy as useless investigations which have led to no result; and this may account for the quantity of work published which lapses into oblivion, only the residue of grain being winnowed from the chaff by time, and becoming part of the mental store of the mathematician. Such investigations, however, in some cases may not be altogether lost, as they may contain the germs of ideas which may fructify in the minds of other workers in the same field of labour.

It seems now that the theory of invariants and the other products of the modern mathematical idea are as necessary a part of mathematical knowledge as the differential and integral calculi. We have had many other new ideas introduced into mathematics, as, for instance, Hamilton's Quaternions and Grassman's method; but we have no conviction of their forming a necessary part of our knowledge. There has been, in fact, of late years too great a tendency to originate such calculi. They seem liable to degenerate into mere playthings, and I believe, also, that they have not availed to obtain any new results, but rather prove prejudicial to the endeavour to do so.

However, the want of all the modern methods never prevented some of the older school of mathematicians from arriving at the solutions of problems to which they had devoted themselves. In fact, these powerful intellects were able, no doubt, to really use the modern machinery intuitively. We see how great mathematicians frequently arrived at results, of whose correctness they were assured, but by means of which they found it difficult to give an explanation; as, for instance, Laplace, whose second proof of Legendre's problem, in the fourth chapter of the third book of the *Mécanique Céleste* was shown to be altogether unsatisfactory by Liouville, in his *Journal de Mathématiques*, t. ii., 1837.

The modern ideas seem to place the true position of mathematics in a clearer light, both with respect to philosophy, on the one hand, and physical science, that is experience, on the other. Mathematics alone seem to give us a firm standpoint of absolute truth, completely free from the mist of our subjectivity; for although we arrive at the primary mathematical truths by means of experience, yet we have a conviction that they are necessary and do not depend upon that source. Mill, however, disputes this; and, among other remarks on the subject, observes that there exist no real things exactly conformable to the definitions of geometry; also, that we cannot conceive a line without breadth, or form a mental picture of such a line. This may, of course, be conceded; but it may seem a preferable view to regard geometrical conceptions rather as qualities than as actual embodiments of matter; for instance, we may regard a surface as the limiting form of a portion of matter. In any case, our inability to realize in nature the so-called imaginary objects arises from the fact that we are finite beings, and cannot secure perfection in the infinitely small.

Since the modern mathematical ideas have come into operation, geometry has broken away from, and become almost independent of, experience—the original foundation on which it stood. In the Euclidian geometry we start from lengths and angles. The circle is the most important curved line which comes under our notice, and these conceptions, at least from Riemann's point of view, depend upon experience. But the modern geometry can be built up without any reference to lengths and angles, or of such a curve as a circle. We can then assume certain properties of space, and hence deduce a consistent geometry of lengths and angles. These assumptions may be made so as to give us either the Euclidian or the elliptic and other kinds of space. In these kinds of space lengths and angles are the forms assumed by certain invariants in the more general geometry.

To give vividness to our conceptions in abstract geometry, we imagin lines and surfaces, as we see and know them in our Euclidian space but the results obtained by mathematical operations have no relatio to, and are completeiy independent of, any definitions of length, an still remain true, if space possessed properties altogether different fro those which it has been found to have from experience. That is, course, provided these results are stated in the most general form i accordance with the ideas of modern geometry.

From the algebraic point of view there is such a thing as a pur perfectly neutral space. Such a space would not be cognisable by ou senses, for it does not possess any attributes—it does not involve th existence of length, of area, or volume. In order to realize these idea the mathematician finds it necessary to suppose the existence of som absolute surface or curve, which, for the ordinary Euclidian space is curve of the second order, and in the elliptic space is a surface of th same order.

The Euclidian geometry forms the connecting-link between algebr and modern geometry on the one hand, and physics on the other Physical mathematics may inform us that there is something peculiarl appropriate in having the law of attraction in nature equal to that o the inverse square of the distance, but still we do not perceive any *priori* necessity for such a law. On the other hand, it may be concede that we have the idea of necessary truth in arithmetic or algebra, bu it does not seem so easy to assign the exact boundary; for, accordin to Riemann, the belief that our space is Euclidian is founded or experienee, while the more usual view seems to be that it is necessary truth.

XV.

ON TESTOONS OF HENRY VIII., WITH DETAILS OF AN UNDESCRIBED TESTOON OF THE BRISTOL MINT, COINED BY SIR WILLIAM SHARINGTON. By W. FRAZER, F.R.C.S.I., Member of Council, R. I. A.

[Read May 14, 1888.]

Silver coinages struck during the reign of Henry the Eighth are distinguished by their progressive deterioration in intrinsic value, and by increasing adulteration of the silver used in their fabrication. After he ascended the throne on 22nd April, 1509, his first issue of coinage consisted of silver of the recognised standard, and each penny piece weighed twelve grains. He utilized for his dies the side-face portrait employed in striking his father's coins, economically adding to the VII. of the old inscription another stroke, which by a simple process became VIII. So matters continued until the commencement of the eighteenth year of his rule, when a special side-faced portrait of his own was engraved to take the place of that of his father. The silver bullion continued to be maintained at standard, but the weight of the penny was reduced to 10½ grains, and so rateably other silver coins were struck according to this diminished valuation.

A more serious change for the worse was introduced in the thirty-fourth year of Henry's reign, when the silver coinage known as his third issue was made. This corresponds in time from April, 1542, to April, 1543. They consist of a silver adulterated to the extent of ten ounces of the pure metal mixed with two ounces of alloy, and the weight of the silver penny was reduced to ten grains. In addition to the usual series of silver coins, consisting of groats, half-groats, pence, and halfpence, which had been struck during every successive reign since the days of Edward III., for the first time a new coin appears, the Testoon, an important monetary novelty, for it was the direct predecessor of our shilling, a name given to it in the succeeding reign of Edward VI. On this testoon the monarch was represented crowned, in royal robes, with full-faced actual portrait, instead of the ideal kingly figure found on all our earlier English coins previous to the latter part of the reign of Henry VII.

For the first time also the title of REX HIBERNIAE was assumed and, as we know, the Act of Parliament which recognised that title wa passed in the thirty-fifth year of Henry the Eighth's reign, it ap pears more than probable that coins displaying this new regal ranl cannot have been issued earlier, although they may have been strucl by the King's order at the mint during the previous year, preparatory to their being put into circulation so soon as the novel title was legally recognised. A few specimens of these earlier testoons are known struck in good silver, but they are few, and were probably what col lectors call trial or pattern pieces; but Henry evidently thought this a needless waste, and assumed that the magnificence of his new rank ought to compensate his subjects for employing a baser kind of meta in making his current coin.

The thirty-sixth and thirty-seventh years of Henry's reign brought about a lower degree of debasement. A composition consisting of one-half silver melted with one-half of alloy was employed, and it is to these later years that the testoons of the Bristol Mint which I wish to dwell on are ascribed. They were struck under Sir William Sharington, Mint Master, who was employed to a great extent in fabricating coins of similar defective value for circulation in Ireland. We have no difficulty in recognising the coins which Sir William Sharington was responsible for, as they have his distinctive mint mark impressed on them—a cypher consisting of the letters W. and S. joined.

The subsequent history of Sir William Sharington's connexion with the coinage of England is a remarkable one. Recent investigations by Mr. John Evans, published in the *Numismatic Chronicle*, have established satisfactorily the fact that, after the death of Henry VIII., gold coins were issued from different English mints which still bore his inscription, but possess a youthful monarch's portrait, substituted for that of bluff King Henry, and there can be no reasonable doubt that his base silver coin continued to be minted without alteration of dies until about the year 1549, when tardy efforts were made to improve the wretched debased coinage and raise the silver standard.

Sir William Sharington held office as Master of the Bristol Mint, which was in full operation until the fall of Lord Seymour, of Sudeley, High Admiral of England, on January 17th, 1549, nearly two years after the death of Henry, when Seymour was committed to the Tower and accused of conspiring with Sharington to counterfeit for him large sums of debased coin and light money. Sharington's confession of his guilt followed, and he admitted having struck no less than £12,000 in

testoons without the Royal Warrant. Such is a brief statement of an obscure and interesting episode in the records of British Numismatics.

It followed, as a matter of course, that as soon as a public statement was made that these coins were illegal, anyone holding them would be inclined to have them destroyed, especially, as if discovered, their owner might be suspected of sympathy with the attached Lord Seymour.

In addition to this, we know that base silver coins must necessarily drop out of circulation from their complete worthlessness for trade purposes. Whatever be the cause, the fact is certain, such testoons are exceptionally scarce; it was therefore with some interest I obtained a series of good specimens for my cabinet. Their possession induced me to investigate the literature bearing on their history, and on corresponding with the authorities in the British Museum, and some of the great private collectors in England, I ascertained that I was in possession of three different issues, distinguished by variations in the inscriptions on the obverse of the coins, that is around the King's portrait, only two of which had been previously recognised and described. I had, therefore, the gratification of obtaining fine specimens of an extremely rare English coin for my cabinet, and, further, of being able to place on record a new and previously unknown type.

The different inscriptions, as will be seen from the drawings and coins shown to the Academy, read as follows:—

HENRIC 8 D G ANG FRANC Z HIB REX
HENRIC 8 D G ANGL FRA HIB REX
HENRIC 8 D G ANGLIE FRA HIB REX

Of the varieties already described, one is distinguished by a *Fleur-de-lis* after the abbreviated word ANG, and the succeeding word FRANC is pretty fully given. The second variety has ANGL, followed by a Cinquefoil and FRA abbreviated. The last piece, which has heretofore not been noticed, has ANGLIE in full, followed by the Cinquefoil. Of this coin, the British Museum contains no example, and so far as I can ascertain, it is not found in any known private cabinet. Its special claim to be brought before this Academy lies in the fact that it was fabricated at the Bristol Mint by the Mint Master, Sharington, to whom we are indebted for the Base Irish coinage issued by Henry VIII., and which was probably continued to be struck by him during the first years of Edward the Sixth's reign.

Above all, it belongs to the earliest period at which the title o Ireland's King was added to the older titles of the English Crown.

The wood engravings represent the obverse and reverse of this previously undescribed variety of the Base Bristol Testoons of Henry the Eighth.

XVI.

ON SOME ANCIENT MONUMENTS, SCHEDULED UNDER SIR JOHN LUBBOCK'S ACT, 1882. By T. N. DEANE. (With Plate IX.)

[Read May 10, 1886.]

Rath of Dowth.

The accompanying plans and sections of this structure (Pl. IX.) illustrate the result of excavations which have lately been carried out.

From time immemorial the existence of the cruciform chambers was known, as well as the small chambers towards the south, commonly called the King's Tomb. The entrance to these is by a passage 27 feet long, formed by eighteen upright stones, and covered with slabs of great size. The central chamber is octagonal, 8 feet between the sides; the chambers right and left are 6 feet long, formed by five stones each. The chamber forming the head of the cross is also formed of five stones, and is 5 feet 3 inches from end to end.

The King's Tomb is 9 feet 9 inches by 3 feet 6 inches, beyond which is a second chamber, 4 feet by 3 feet 6 inches, and to the north of it two smaller chambers. On the floor of the central chamber is the hollowed slab, so frequently found in similar structures: nearly all the lining stones of the central chamber are covered with devices, the character of which I shall refer to hereafter.

The form of the rath is circular, about 300 feet in diameter, by an average of 45 feet high.

The entire is surrounded by stones of great size, set on edge. Certain indications of further subterranean passages gave the clue to the excavations which have been carried out, and resulted in the discovery of some new portions. Commencing at the northern side of the known entrance to the central chamber, an opening was made which led to a passage terminated at either end by circular cells carefully roofed with corbelling stones. In this passage were found a quantity of bones, mostly horses and lower animals, but none human.

The passage had an incline towards the south. On emerging from it at the point where it met the entrance to the originally known chamber a flight of steps was discovered. I have no doubt that these chambers were approached only by this passage, and that the entrance used for many years was made for investigation of the contents of the central portion.

In the circular cell at the southern end of the curved passage we found three articles—a bronze pin, a buckle, and an iron dagger.

I have shown these to Dr. Frazer, whose opinion is worthy respect, and he looks on the pin and dagger as Danish, and the buck Irish work. Should he be correct, it would lead to the suppositi that the tomb had been rifled, of which I have no doubt, for read in the *Annals of Ulster*, that in A. D. 862 "The cave Achac Aldai and Cnodhba (Knowth), and this sepulchre of Boadan ov Dowth, and the cave of the wife of Gobhan, were searched by th Danes, quad antea perfectum est, on one occasion that the three kin Aruloff, Imai, and Anish were plundering the territory of Flan the son of Conaing."

To the south of the passage described further excavation wa carried on, and a curious chamber was discovered, 14 feet in diamete surrounded by massive stones, most of which are covered with simila carvings to those found on the cruciform chamber. This chambe appears to have been approached by a passage towards the south-wes also formed by very large stones. On the largest stone to the righ there are four hollows.

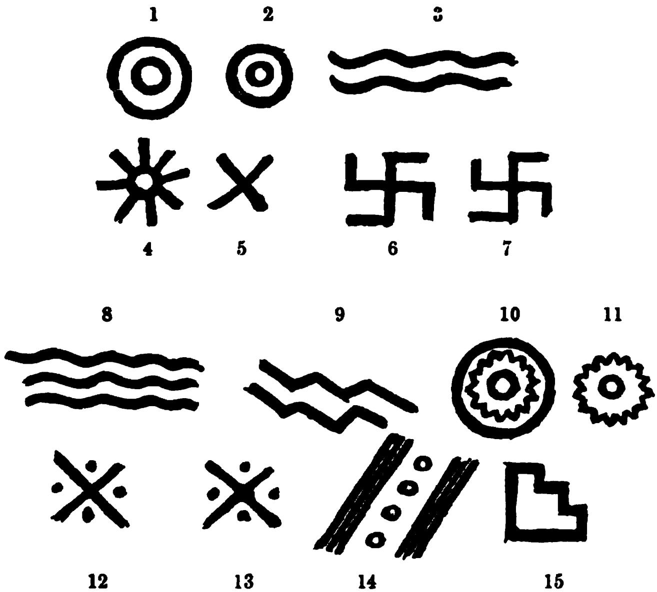
The obscurity as to the meaning of the devices carved on thes stones has led me to compare them with markings on pottery, als with masons' marks used at the present day and in past ages both i India and other parts of the world. The devices on the pottery of th Zuni Indians (of which they are able to give explanations), which ar seen on the ware obtained for the University of Oxford, and so beauti fully illustrated in the Proceedings of the Smithsonian Institute a Washington, may help to give a clue to the reading of the device at Dowth, Loughcrew, and elsewhere.

I find many similar devices on the Egyptian ware correspondin with those at Dowth. To follow the analogy further, I show masons marks of the present day; others, from India, as old as the eleventh century; and I am now collecting those of mediæval times, which will enable the reader to compare notes, and further investigate this very interesting subject.

The mark known as the Swastika—

is common to India, Cyprus, and Ireland. In the churchyard at Dingle I have found this on a very ancient tomb.

The cruciform shape of a chamber or a device must not lead to the opinion that it is Christian; it is more likely to be a symbol of the sun.



Figs. 1, 2, 10, and 11 represent the Sun. Fig. 1, from Dowth; figs. 2, 6, 8, 13, from Cyprus; figs. 3, 4, 5, and 10, from Loughcrew; figs. 9 and 11, from Zuni; figs. 7 and 12, from India; fig. 14, from Hail Zuni; fig. 15, from Cloud Zuni.

I do not pretend to explain the devices on Dowth, but merely wish to give a clue to further investigation and comparison. I think that there can be little doubt that these markings are astronomical, or connected with the elements when these effected the feelings and habits of the people at the time they were made. No doubt, some of the markings tend to the belief that they were made to illustrate the ramifications of the rath they were made in, or in surrounding similar structures.

Those especially on the rocks near to Staigue Fort in Kerry lead me to this theory. Those were partially examined by the late Lord Dunraven; but much more remains to be done, and a careful investigation of the Aicha remains of that part of the country ought to be made.

The works at Dowth are completed; the crater formed in the to
of the moat has been partially filled up, and the chambers and passage
are protected, and left in such a manner as will enable them to be ex
plored. At Dowth Hall there is a most interesting moat which ha
been opened from the top, and is well worthy of being placed unde
protection.

Loughcrew.

The tombs on the Loughcrew Hills have also received attention
these were thoroughly examined in 1865. The interesting account b
Eugene Alfred Conwell, Esq., so carefully describes them, that it i
almost needless to go into further particulars.

The great danger to these monuments is the exposure to th
atmosphere of the inscribed stones. A prolongation of the entranc
covered by a rough arch has been thought the best way of preservin
them. This is being done.

Considerable delay in the investigation of many of the monument
scheduled under the Act of 1882 has arisen from the unwillingness o
the owners to place them under the charge of the Government. A
instance, New Grange, Knowth, and several others. This difficulty i
gradually being overcome, and I have little doubt that a more searching examination will in many instances lead to interesting results.

The discovery at Dowth, that the entrance known as the central
chamber is now proved not to be the original one, opens a field for
considerable exploration.

For many years it has been the desire of antiquaries to explore
Knowth, but I regret to say the owner is unwilling to permit a search
being made.

I am in great hopes that when it is fully understood that the vesting of a monument does not involve an infringement of territorial rights
the difficulty will be overcome, and monuments now neglected will be
placed under supervision. It is, however, a subject for congratulation
that such monuments as are scheduled under the Act of 1882 are, owing
to the feelings of the people, safer from demolition than in other
countries. What are called giants' rings, moats, and druidical altars,
have a halo cast about them which preserve them from demolition.
Pillar-stones are not so: these afford scope for destruction. Why it
is so, I cannot say.

During the current year I hope to investigate thoroughly the cromlechs in Glen Mauter, county Donegal, which have just been vested

in the Board of Works, and to take steps for their protection. I also hope that the great Rath of Dunkellain, near Downpatrick, will be vested in the Board. It is one of the grandest specimens of an earthwork in Ireland, enormous in dimensions, and of great archæological interest, being connected with the history of the Red Branch Knights.

I regret to say that the interesting ruins of Staigue still remain uninvested, and that at present there is little hopes of their being so. The district in which they stand is full of objects worthy of preservation, and it is only to be hoped that at some future day the power of placing objects of such great antiquity and interest as exist in Ireland will arrest the attention of the Royal Irish Academy and other bodies, who should endeavour to place them in such position as will not only preserve them from injury, but lead to their investigation.

XVII.

ON THE VARIABLE STAR μ CEPHEI. BY J. E. GORE, F. R. A. S.

[Read April 9, 1888.]

This interesting variable—the "garnet star" of Sir W. Herschel—was found to be variable by Hind in 1848, and the variability was confirmed by Argelander, who made numerous observations of it in the years 1848 to 1864. According to Schönfeld (*Zweiter Catalog von veränderlichen Sternen*, 1875), Argelander's observations give the formulæ—

Epoch E. Min. 1855, Oct. 15·6; Max. 1856, June 20·1 + $431^d{\cdot}786$ E.

I have observed the star for a number of years, and find it certainly variable to the extent of a little over one magnitude, but with no regular period. The period of 431·786 days, given in Argelander's formula, is not confirmed by my observations, which, I think, show that the variation cannot be represented by any fixed or mean period. The following are all my observations of the star to the end of 1887. Its red colour, and at times strong scintillation, render a correct estimate of its magnitude somewhat difficult. My comparison stars are as follows, and the magnitude of these are assumed from the measures in the "Harvard Photometry":—

Comparison Stars for μ Cephei.

	Mag. H. P.
ζ Cephei,	3·54
ϵ Cephei,	4·24
ν (10) Cephei,	4·50
9 Cephei,	4·79
λ Cephei,	5·29.

The position of μ Cephei is for 1890·0, R. A. $21^h\,40^m\,8^s$, N. $58^\circ{\cdot}16'{\cdot}5$. The observations were chiefly made with a binocular field-glass, having object-glasses of 2 inches aperture, and power of about 6 diameters. Occasionally, when near a maximum, the star was also observed with the naked eye. Argelander's method was employed.

OBSERVATIONS OF μ CEPHEI = BAC 7582.

Date.	Estimated Mag.	Remarks.
1874. Sept. 29.	4·79	Observation made in the Punjab, μ = 9 Cephei.
1878. April 6.	4·14	Do. do.
1882. Jan. 12.	4·24	
1883. Mar. 17.	3·8	μ very very red, and scintillating greatly; strong moonlight.
April 8.	4·4	Clear sky; no moon, 9.45 P.M.
„ 20.	4·4	Moonlight, 9.20 P.M.
Sept. 4.	4·8	No moon; evidently near a minimum.
Dec. 30.	4·24	
1884. Jan. 21.	4·55	
„ 31.	4·37	
Feb. 7.	4·20	Strong moonlight.
„ 10.	4·0	Full moonlight.
„ 22.	4·2	Clear sky; no moon.
Mar. 4.	4·3	
„ 17.	4·55	*Very* clear sky, no moon.
„ 21.	4·20	No moon.
„ 24.	4·2	Hazy sky.
April 1.	4·3	Moonlight.
„ 7.	4·1	
„ 9.	4·1	Very red, with binocular; difficult to estimate magnitude, owing to violent scintillation, 8.50 P.M.; strong moonlight.
„ 19.	4·0	9 P.M.; no moon; slightly brighter than β Lacertæ, 10 P.M.
„ 20.	4·0	No moon.
„ 26.	4·1	No moon.
May 12.	4·04	Moon rising.
„ 17.	4·14	No moon, 10 P.M.
„ 22.	4·04	No moon, 10½ P.M.

Date.	Estimated Mag.	Remarks.
May 28.	4·16	No moon; strong twilight, 10 P.M.
Sept. 13.	4·0	μ at a high altitude, 8.20 P.M.; no moon.
,, 18.	4·0	Do. do. do.
Oct. 1.	4·07	Do. do. moonlight.
,, 16.	4·0	μ at a high altitude; no moon.
Nov. 2.	3·75	μ near zenith; strong moonlight.
,, 9.	3·64	μ brighter than I have ever seen it before, and light steady.
,, 12.	3·9	Clear sky; no moon.
,, 21.	3·8	Clear sky; crescent moon setting.
Dec. 21.	3·9	Clear sky; no moon.
1885. Jan. 5.	3·8	Clear sky; no moon.
,, 13.	3·9	No moon; freezing.
,, 30.	3·7	μ very little inferior to ζ Cephei; full moonlight, $7^h\ 50^m$ P.M.
Feb. 3.	3·74	No moon; $6^h\ 40^m$ P.M.
,, 13.	3·64	μ very bright; only 1 step less than ζ Cephei with naked eye and binocular; light of μ very steady; hazy sky; no moon, $7^h\ 20^m$ P.M.
,, 14.	3·7	Very clear sky; no moon, $8^h\ 30^m$ P.M.
,, 18.	3·74	Clear sky; crescent moon, $6^h\ 50^m$ P.M.
,, 22.	3·74	Considerably brighter than ϵ Cephei; moonlight, 7.40 P.M.
,, 24.	3·74	Clear sky; moonlight, 9.50 P.M.
,, 26.	3·82	Hazy sky; moonlight.
March 6.	3·95	Clear sky; no moon.
,, 11.	3·8	Do. do.
,, 13.	3·9	No moon.
,, 22.	3·74	Clear sky; moonlight.
,, 27.	3·74	Clear sky; strong moonlight, 9.5 P.M.
May 11.	3·6	μ equal to ζ Cephei, with binocular, but slightly less with naked eye; no moon, 10.10 P.M.
July 28.	3·64	Very clear sky; strong moonlight, 10 P.M.
,, 30.	3·64	Do. do. do.

Date.	Estimated Mag.	Remarks.
Aug. 13.	3·64	Very clear sky; no moon; twilight, 9.20 P.M.
,, 19.	3·74	Clear sky; moonlight.
Sept. 7.	3·84	Clear sky; no moon; light of μ steady.
,, 9.	4·22	μ near zenith; no moon, 9.30 P.M.
,, 13.	4·02	Clear sky; no moon.
,, 16.	4·02	Clear sky; moonlight.
,, 30.	4·02	Clear sky; no moon.
Oct. 12.	4·02	No moon.
,, 22.	3·94	Moonlight.
Nov. 4.	4·09	No moon.
,, 15.	4·00	Moonlight.
,, 21.	3·89	Moonlight, 5.53 P.M.
,, 30.	3·84	No moon, 7.15 P.M.
Dec. 4.	3·94	No moon, 7.30 P.M.
,, 9.	3·84	Clear sky; no moon, 8.50 P.M.
,, 16.	3·84	Clear sky; strong moonlight.
,, 22.	3·84	Do. do.
1886. Jan. 13.	3·84	Clear sky; moonlight.
,, 16.	3·84	Do. do.
Feb. 3.	3·89	Clear sky; no moon.
,, 14.	3·89	9.10 P.M.; colour of μ not much deeper red than ζ Cephei.
March 3.	3·77	Very clear sky; no moon.
,, 6.	3·89	Do. do.
,, 10.	3·86	Moonlight; rather hazy sky; strong scintillation in μ.
,, 13.	3·89	Very clear sky; moonlight.
,, 17.	3·89	Strong moonlight.
,, 29.	4·04	Clear sky; no moon; μ very reddish.
April 2.	3·89	No moon; sky hazy.
,, 7.	4·14	Very clear sky; moon just set, 10 P.M.

Date.		Estimated Mag.	Remarks.
April	14.	4·14	Clear sky; strong moonlight.
,,	16.	4·14	Very clear sky; strong moonlight; μ red-orange.
,,	27.	4·2	Between clouds; no moon.
,,	28.	4·2	Considerably less than ζ Cephei; very clear sky; no moon.
May	14.	4·14	Clear; strong moonlight, 9.55 P.M.
,,	19.	4·02	Clear sky; twilight, and moon rising.
,,	21.	4·14	Clear sky; twilight.
,,	22.	4·14	Strong twilight, 10.15 P.M.
,,	26.	4·14	Clear sky; strong twilight, 10 P.M.
June	12.	4·14	Do. do. 10.30 P.M.
July	21.	4·14	Strong twilight; some clouds, 9.45 P.M.
Aug.	14.	4·38	Moonlight; some clouds, 9.50 P.M.
,,	22.	4·50	$\mu = \nu$ (10) Cephei; no moon; some clouds, 9 P.M.
,,	28.	4·50	No moon; clear, 10 P.M.
,,	29.	4·38	Clear; no moon, 9.15 P.M.
,,	31.	4·38	Clear sky; no moon.
Sept.	2.	4·38	Clear sky; moon setting, 8.35 P.M.
,,	3.	4·38	Do. moonlight, 8.20 P.M.
,,	6.	4·26	Do. do. 8.3 P.M.
,,	8.	4·38	Clear between clouds; moonlight, 9.15 P.M.
,,	14.	4·26	Strong moonlight.
,,	15.	4·26	Clear sky; moon not risen; twilight, 7.50 P.M.
,,	16.	4·38	Do. twilight, 7.40 P.M.
,,	17.	4·38	Do. no moon, 8.5 P.M.
,,	18.	4·38	Do. do. 7.45 P.M.
,,	20.	4·38	Sky hazy; no moon, 7.50 P.M.
,,	22.	4·38	Clear sky; strong twilight, 7.10 P.M.
,,	27.	4·38	Clear sky; no moon.
Oct.	1.	4·38	Do. do.

Date.	Estimated Mag.	Remarks.
Oct. 10.	4·38	Clear; moonlight and twilight, 6.35 P.M.
„ 12.	4·26	Clear; strong moonlight, 7.22 P.M.
„ 16.	4·38	Clear; no moon, 7.15 P.M.
„ 20.	4·26	Hazy; no moon.
„ 23.	4·26	Clear sky; no moon.
„ 24.	4·26	Do. do.
„ 25.	4·26	Do. do.
„ 26.	4·14	No moon; sky somewhat hazy.
„ 28.	4·26	Do. do.
„ 31.	4·38	Clear sky; moon setting.
Nov. 1.	4·38	Clear sky; moon set.
„ 3.	4·26	Clear; moonlight.
„ 4.	4·26	Moonlight.
„ 8.	4·26	Do. clear sky.
„ 10.	4·26	Do. do.
„ 16.	4·26	Clear sky; no moon, 5.50 P.M.
„ 20.	4·26	Do. do.
„ 23.	4·14	Do. do.
„ 26.	4·26	Do. do.
„ 28.	4·26	Clear sky; no moon.
„ 30.	4·14	Do. do.
Dec. 12.	4·14	Strong moonlight.
„ 13.	4·14	Do.
„ 16.	4·14	Clear; no moon.
„ 22.	4·14	Do.
„ 24.	4·14	Do.
„ 25.	4·14	Some clouds; no moon.
„ 27.	4·14	Hazy sky; no moon.
„ 30.	4·10	Clear sky; no moon.

Date.	Estimated Mag.	Remarks.
1887. Feb. 5.	3·90	Strong moonlight.
„ 8.	4·07	Do.
„ 10.	4·07	Do.
„ 11.	4·07	Clear; no moon.
Mar. 15.	4·07	Do.
„ 29.	3·95	Clear; crescent moon.
April 6.	3·90	Clear; strong moonlight.
„ 8.	3·90	Do. do.
„ 12.	3·90	Clear; no moon.
„ 16.	3·90	Do.
June 9.	3·97	Clear; strong moonlight, 10.45 P.M.
Sept. 7.	4·07	Clear; moon rising, 8.40 P.M.
„ 29.	3·97	Strong moonlight, 8.20 P.M.
„ 30.	3·97	Clear; strong moonlight.
Oct. 8.	3·97	Clear; no moon.
„ 9.	3·97	Very clear sky; no moon.
„ 25.	3·86	Clear; strong moonlight.
Dec. 10.	4·07	Clear; no moon.
„ 11.	4·07	Clear; no moon; freezing.
„ 16.	4·07	Do. do.
„ 17.	4·07	Clear; moon setting, 6.20 P.M.
„ 21.	4·07	Clear; strong moonlight; μ very reddish.
„ 24.	4·07	Do. do.
„ 27.	3·97	Do. do. freezing.

The highest recorded magnitude was 3·6 on May 11, 1885; and the lowest 4·8 on Sept. 4, 1883. The star is therefore variable from 3.6 M. to 4·8 M. on the scale of the Harvard Photometry. The variation is very irregular, the star sometimes remaining for several months at a time with scarcely any perceptible variation.

The spectrum of μ Cephei is a fine specimen of Secchi's third type.

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XVIII.

REPORT ON THE PREHISTORIC REMAINS FROM THE SAND-HILLS OF THE COAST OF IRELAND. By W. J. KNOWLES. (Plates X.-XIII.)

[Read January 14, 1889.]

Introduction.

The present Report is the result of an examination of twelve prehistoric stations on the Irish coast. Roughly, my survey takes in from Dublin round the eastern, northern, and western coasts to Sligo; but every spot in this extent of coast where ancient remains are to be found has not been examined, as it was found that all the work which I had laid out for myself was too much for a single season. Enough has, however, been done to afford a general view of the implements and also of the habits of life of the early settlers on this portion of the Irish coast, and it is my intention to devote whatever time I can spare to a continuation of the work next year. Some of the stations have been previously reported on by me, but most of these have been examined again during the past year, with the view of obtaining further information, and of enabling me to give a more connected Report. Other places, which shall be described, have not yet been brought by me under the notice of any scientific society. The stations referred to are Whitepark Bay, the Giant's Causeway, and Portrush, in county Antrim; Portstewart and Grangemore, near Castlerock, in county Londonderry; Dundrum, in county Down; Drogheda, in Meath; Malahide, in Dublin; Buncrana, Dunfanaghy, and Bundoran, in Donegal; and Stredagh, near Grange, in Sligo. In all these places there will be found among the sand-hills blackened layers, which are the remains of the old surface on which the prehistoric people lived. In many instances the old surface has a covering of sand, varying in thickness from two or three feet in one place to perhaps over fifty in another; but there are other parts where the sandy covering has been entirely removed by the wind, and the old surface has been again laid bare. In such cases the foundations of the people's huts can be seen standing out above the level of the original surface, and

there will be found resting on it, and projecting from it, implements, shells, and broken and split bones. In digging into this old surface we will find the cores from which flakes were struck off, the flakes themselves and implements made from them, the hammer-stones used in striking off the flakes, and the rests, or anvil-stones, used for resting the core on when being struck with the hammer-stone. Fragments of pottery, pins and needles of bone, and a variety of other objects, may be found buried up in this dark-coloured old surface. The black colour is largely due to the fragments of charred wood which the old surface contains; but the absorption of decaying animal and vegetable matter, which would, no doubt, be constantly thrown about at the time of occupation, must have assisted in darkening it. In addition to its difference in colour from the sand above and below, the old surface is also firmer, and resists the denuding action of the wind longer, than the discoloured sand; therefore we find occasionally large patches of it lying bare; but in many instances the old surface itself has also been carried away, and the implements and other remains which it contained will be found lying on the sand. In such cases dark bands will be seen along the sides of the pits. These bands are the edges of the old surface, and it was seeing it appear in this way which first led me to call it the black layer. This old surface varies in thickness from three or four inches up to three feet. It is sometimes very rich in remains, and at others nearly barren. The most productive parts are generally to be found in the immediate neighbourhood of the hut sites.

Whitepark Bay.

The old surface at this place has proved very rich in prehistoric remains, and it is still very far from being exhausted. The sandy covering has been removed within a comparatively recent period, as I learned from an old man in the neighbourhood, that he remembered its being covered with a grassy sward where it is now bare, and cattle grazing on it, and several portions of the covering, which within my own memory stood up as pillars, with a grassy sward on the top, have now vanished. I have spent a good amount of time among these sandhills during the past fifteen or sixteen years, and have obtained a large series of objects, and some of my archæological friends, who are now very well acquainted with the nature of the place, have obtained numerous specimens. I believe it would be no exaggeration to say that between 3000 and 4000 manufactured articles have been already

collected. Reports of these finds have been given from time to time to scientific societies, and at the Portrush meeting of the Royal Historical and Archæological Association of Ireland, in 1885, I read a revised account of the discoveries at Whitepark Bay, which is published, with illustrations, in their Journal, vol. vii., Fourth Series, p. 104. Whitepark Bay is bounded by chalk cliffs, and a large quantity of flint nodules, which have been set free by denudation, are to be found in the talus at the base of the cliffs. The necessary material being plentiful and easily obtained, the flint implements are mostly large, as well as abundant. There is also a profusion of flakes, chips, and cores. The flakes, as a rule, are irregular in shape, mostly short and broad. The long-pointed, spear-like kind is rare, though an occasional specimen is found. A very perfect flake of this kind, dressed at the tang and along the sides, was excavated from the old surface about a year ago, and is shown in Pl. XII., fig. 4. Scrapers are the most numerous of the flint implements, and are of various patterns. Some show very coarse workmanship, but others are neatly finished, and are occasionally dressed round the entire edge, as in the example shown, Pl. XII., fig. 3. We find many scrapers having the part which has been dressed for scraping rather pointed, and in some the part dressed for scraping is a straight edge. An example of the pointed kind is shown in Pl. XII., fig. 9, and one with a straight edge in Pl. XI., fig. 3. Several large spalls of flint have been found, which, though they have no very definite shape, and do not show any general likeness, yet present many signs that they have been used for cutting or chopping. These lead up to others, which are more or less dressed at the sides, and have the appearance of rude axes or chisels. There have also been found several coarse spear- or lance-heads; a few objects that might be called arrow-heads, though very rude; several borers, and some roughly-chipped, ball-like objects, sometimes called sling-stones, but in reality intended for hammer-stones, as can easily be demonstrated when a series, showing various stages of use as hammers, is seen together. A good typical specimen of the hollow scraper, as far as my experience goes, has not yet been found at this station. I have obtained many hammer-stones, anvil-stones, bone pins, pieces of ochre and chalk, both scraped and rubbed; several examples of saddle querns and other stones of smaller size, which have a smoothed surface, arising from use in rubbing or grinding. Fragments of pottery, variously marked; the teeth and split bones of animals, which must have been used as food, and shellfish of various kinds, no doubt also refuse of the food used by the people, are all

plentifully found in the old surface, mixed up with the other objects I have mentioned. In digging over the black layer I mostly used a garden trowel, and took the greatest care in examining the smallest object, and though the majority of the various articles were found loose on the surface, I have obtained a large series of all the classes enumerated directly from the old surface. It is a mistake to call the implements obtained from this old surface palæolithic, but flakes and cores of an older series are found lying along the shore of the bay. These are greatly weathered, and are easily known by their reddish-brown crust. That they were old and crusted when the neolithic flint-workers occupied the sand-hills is evidenced by the numbers which have been re-worked by these people. In many flakes we will find the old weathered surface of the older core on one side, and the fresh fracture made by the later people on the other side. We cannot, however, say that even this older series is palæolithic, as they are not found in connexion with remains of any extinct animal. Although flint was abundant, it did not prevent these ancient people of the sand-hills from working up other rocks into implements, as I obtained some objects made from the hardened chalk and altered lias. I have made several visits to Whitepark Bay during the past year, in the interest of the Academy, and have obtained 11 hammer-stones, 1 anvil-stone, of regular oval shape, indented on both sides, which is shown in Pl. XII., fig. 5; 3 rude choppers, 60 scrapers, 2 cores, and 1 bone pin, shown in Pl. XII., fig. 6, besides fragments of pottery and flakes. I figure another small anvil-stone of chalk from Whitepark Bay. (See Pl. XII., fig. 2.) This is a very small implement of this class, but that shown in fig. 5 of Pl. XII. is about medium size. Some are large and irregular in shape, as in the case of an example presented from Buncrana. As anvil-stones are little known, and generally overlooked, I figure several specimens from the different stations. A small flint axe from Whitepark Bay is shown in Pl. XI., fig. 4.

The Causeway.

There are sand-hills between the Giant's Causeway and Bushmills, but the old surface has not been laid bare in any of the pits which I have examined. The sand-hills have, however, been occupied by the flint-working coast tribes, as can be seen very plainly in a section formed a few years ago to obtain material for making an avenue to Lord M'Naghten's new residence. The gravel of the raised beach,

with weathered flints like those from Larne, is seen below, and on the top of the gravel comes the old prehistoric surface, blackish as at other places, and containing unweathered flakes and chips.

PORTRUSH.

Several objects have been found in the sand-hills at Portrush from time to time. In two pits, near the chalk quarries, on the road to Bushmills, I found, many years ago, fine large cores, flakes, and scrapers, with the usually accompanying teeth and shells. In the sand, close to the town and along the shore towards Portstewart, I have also occasionally found flakes and scrapers. For several years past sand has been removed from the south side of the street, called Spring-hill, in order to make room for new buildings; and a little over two years ago the old surface was reached, resting almost on the solid rock. A workman, named James Gallagher, dug out of this old surface a number of small flint axes, a coarse spear-head, besides several cores and flakes. The axes, spear-head, and some of the cores and flakes passed into the hands of Captain Robinson, J.P., of West-port House, Portrush, who was kind enough not only to allow me to make drawings of them for the use of this report, but also to give me one of the axes for presentation to the Academy. The find by Gallagher was reported in the papers at the time, and several archæologists were attracted to the spot and obtained some things by digging. I went myself and procured several articles which still remained in the labourer's possession, and others by digging for myself. My son, W. S. Knowles, also dug over some of the old surface, and found among other things a large pointed implement in shape like a palæolithic axe (see Pl. x., fig. 8). The small axes are all wedge-shaped, and the edges have been formed mostly by a single large flake having been removed from each side. Probably a large spall, with sharp side edge, has been selected and then dressed down into an axe. I have seen indications of such a process of manufacture among the objects found at Whitepark Bay. In the specimen shown in Pl. x., fig. 4, the edge is nearly on a line with one of the sides, and a very regular bevelling on the other side gives the axe the appearance of a carpenter's chisel. Some of the cores are small, and have had a series of small flakes removed from them in such a way, apparently, as to leave the core regular in shape and more or less pointed. One is figured Pl. x., fig. 7. Fig. 1 in Pl. x. represents one of the small axes from Portrush in my own possession. Figs. 2, 3, and 4, those

from Captain Robinson's collection; Fig. 2 being the specimen presented to the Academy. Fig. 5 in Pl. x. represents an anvil-stone of altered lias, pitted on one side. Fig. 6 in same Plate is a spear-head, and Pl. xii., fig. 2, shows a borer of flint, also found here.

PORTSTEWART AND GRANGEMORE.

These two places may be considered as one, as they are on opposite sides of the Bann, and the objects found in them present no difference in character. I have given several accounts of the finds from Portstewart, and some of the more important objects are figured in the Journal of the Royal Historical and Archæological Association of Ireland, vol. viii., Fourth Series, p. 221. Arrowheads, scrapers, hollow scrapers, knives, borers, cores and flakes, hammer-stones anvil-stones, bored stones, beads of stone, cut bones and pottery, besides broken and split bones, teeth, and sea-shells were the principal articles found. Examples of most of these were obtained by excavation from the old surface. I did not obtain any of the stone beads directly from the black layer, but they were all found near one of the old hearths, and a labourer who searched for them told me that the best plan was to dig over a portion of the black surface and scatter it about, and when it dried, and that the wind blew off the sand, beads were likely to be found. These beads are small and made of greenish serpentine, which, according to G. H. Kinahan, M.R.I.A., came probably from Donegal. About forty have been found altogether. Though the occupiers of these sites were within about three miles of the chalk rock on the one side, and about seven on the other, in either of which places they could have obtained abundance of large nodules, yet they do not seem to have availed themselves of these sources of supply, but to have been dependent on the pebbles of flint lying about on the surface, or contained in the raised beach. These pebbles are, to a large extent, small cores of the older series which I have already referred to, and which are found here, as well as at Whitepark Bay. The flakes, cores, and implements are, therefore, smaller than those found at Whitepark Bay, where they had, as material for their implements, the large nodules direct from the chalk rock. Several flakes and some arrow-heads of obsidian, or pitchstone, were found, and also some nodules of pumice, one of which had a cord track round it. A lamp of pottery was found by a workman, which is now in the Rev. G. R. Buick's collection. It is supposed to be from

an old surface further inland. A few flakes from a polished stone axe were found. The animal remains found here and at Whitepark Bay were determined by Prof. A. Leith Adams, and found to comprise ox, red deer, pig, sheep or goat, wolf or dog, and man. The remains at other stations are of similar kinds, though not so abundant. A small hammer-stone, with three abraded spots, is shown in Pl. XII., fig. 1.

DUNDRUM.

I was not able to visit the sand-hills at Dundrum during the past summer, but I had previously obtained a large series of implements from them. The arrow-heads were numerous, and beautifully worked, and the scrapers, as at other stations, were the most numerous of all the kinds of implements, and showed by pieces of weathered crust adhering to them that they were manufactured from small nodules and cores, as at Portstewart. Hammer-stones and anvil-stones were abundant, and several stone axes, both rudely chipped and polished, were obtained. The usual shreds of pottery, bones, and shells were found, but not so plentiful as at other stations. The majority of the objects were procured from hollows or pits among the sand-hills, but they must have dropped from the old surface, as the remnants of it were seen as black layers along the sides, and bared platforms of the old surface stood out from the steep faces of sand in many instances. Sand to the height of 50 feet was seen resting on some of the layers here. I dug over several pieces of the old surface and obtained flakes and implements. On one occasion I happened on an old hearth, and obtained three dressed knives, some scrapers, cores, pottery, a well-marked anvil-stone, hammer-stones, and a polished stone hatchet. On another occasion when I went to explore, at the invitation of the Marchioness of Downshire, we hit on another hearth, and Lord Arthur Hill, who was present, and engaged heartily in the digging, turned out an excellent anvil-stone of large size, cores, scrapers, and hammer-stones, evidently the stock-in-trade of an implement maker. Canon Grainger, who accompanied me on one of my visits to Dundrum, found lying on the surface a stone bead of the Portstewart type, and a "tracked stone" (one of those oval pebbles of quartzite, with an indented line of about an inch in length on each face); but this class of implement is not generally considered to belong to the stone age, and as no specimen of the kind has been obtained from the old surface, I cannot throw any additional light on the matter.

Drogheda.

There are sand-hills between the mouth of the Boyne and Laytown which I examined. I observed that small cores and nodules had been broken up to obtain flakes. Every nodule or flake was smaller than objects of the same kind at Dundrum. I found several small flakes with well-marked bulbs of percussion, some of which have been used in scraping. I also found one of the bones of a human arm.

Malahide.

There are sand-hills lying between this town and the shore opposite Donabate station which I examined, and procured small flakes, cores, and hammer-stones. I did not observe any black layers on the sides of the pits, as the hills would appear to have been planted over with bent to prevent denudation; but the flakes and chips which I procured were sufficient evidence to me that the same race of flint-workers which occupied the sand-hills of the north had extended southwards as far as Malahide. The flint supply was evidently old cores and nodules like those found at Dundrum and other stations, only that they seem to have become smaller and more weathered the farther we proceed southward. I believe that in whatever way these flint nodules were carried towards the south they must have been sifted by the way, the larger ones dropping behind and only the smaller kinds reaching as far as Malahide. In addition to the small flakes I have mentioned I obtained a flake of the older series. I also found an old core at Baldoyle, and an object of the same class at Howth.

Buncrana.

Between Buncrana and Fahan, on the eastern shore of Lough Swilly, there are sand-hills which I examined during the past summer, in company with my son. From pits there we obtained several pieces of flint and one nicely dressed flake of a knife-like character, shown in Pl. xi., fig. 8, two hammer-stones, two anvil-stones, a small longish pebble with two hollows punched on it, somewhat similar to the hollows on anvil-stones, but in this instance they are on the edges instead of the flat faces: owing to the position of the indented parts the stone is narrowed in the centre, and has a likeness to objects occasionally described as plummets. There are two specimens of this

class figured in Nilsson's Scandinavia (Pl. II., fig. 33, and Pl. XI., fig. 216). Some fragments of pottery, the top of a saddle quern, and other objects, were found, the best of which we brought away.

DUNFANAGHY.

I visited this place in the end of the past summer, accompanied by the Rev. Canon Grainger, M.R.I.A. We discovered in the sand-hills near this town a great number of hut sites on the sand. The sandy covering had been all removed, and we counted over fifty sites not far from the shore and beside a stream of fresh water. In some cases the hut sites were very close together, and longish stones against which they had placed their fires were in several cases standing up. Some of the sites showed a boundary of stones but rather irregularly placed. The diameter of one which I found in nearly perfect condition was eight paces, or about twenty-four feet. The old surface and floors were exposed and full of sea-shells. Patella, Cardium, and Littorina, were the most abundant, but Ostrea, Mytilus, Pecten, and Purpura were also present. Remains of red deer, ox, pig, and horse, were found; but here, as at all the other stations, there was a general absence of fish bones. This is rather strange, as most of the sites are in close proximity to good fishing stations. Flint of any kind was very scarce; but I found one scraper, shown in Pl. XI., fig. 1, a small core, and two small flakes. I also show a scraper of quartzite in Pl. XI., fig. 2. They used this material and milky quartz, both of which are found in the neighbourhood, for implements. Delicate chipping, which is so sure a sign of workmanship in flint, does not show on quartz and quartzite, and therefore scrapers and other weapons which were no doubt manufactured from these materials cannot so easily be demonstrated to be artificial productions. I brought away several objects which, in my opinion, were implements, among the rest a small axe of the Portrush type, and some scrapers. I obtained an excellent example of an anvil-stone pitted on both sides. One side is still black from lying on the old surface, and the other side which has been exposed to the weather has the sharpness of the pitting greatly blunted, though the stone is hard quartzite. It is 7 inches long, and 4½ broad, and shows by its abraded ends that it has also been used as a hammer-stone. It is shown half-size in Pl. XI., fig. 5, and can be compared with specimens from Whitepark Bay, Portrush, and Bundoran, which are also figured. Among the objects procured by Canon Grainger was the point of a tine of red deer, partly sawn through. The sawing has

been done with a short instrument, as the cut line is nòt continuous. It can be seen by the lines overlapping that there had been two shifts of the saw in making the cut. It is shown in Pl. xii., fig. 10. I also obtained a piece of bone which has been dressed to a point. It is shown in Pl. xi., fig. 6. The usual fragments of pottery were also found, but none of them ornamented.

Bundoran.

There are extensive sand-hills at this place, which I visited for the first time in 1887. When the Royal Historical and Archæological Association of Ireland met in Enniskillen that year an excursion to Bundoran was arranged, under the guidance of Mr. Thomas Plunkett, M.R.I.A. Canon Grainger, Rev. G. R. Buick, Rev. Leonard Hassé, and myself, accompanied Mr. Plunkett to the sand-hills, and we found scrapers, hollow scrapers, and arrow-heads of chert and flint; but owing to the time allotted to the search for antiquities being very limited, I felt that our examination of such an important place was very hasty and incomplete. I therefore paid a second visit to these sand-hills before the end of the summer of 1887, and obtained 130 chert scrapers, 24 hollow scrapers, a chert arrow-head, a chert "slug," or flake, dressed over the back, a borer, and several other dressed objects of chert, besides some flint scrapers and flakes, and a well-dressed knife of flint broken at the point. I went again this year, in the interests of the Academy, and found 41 chert scrapers, 11 flint scrapers, 6 hollow scrapers of chert, and one of flint, an imperfectly formed arrow-head of chert, a beautiful little flint object combining both the ordinary and the hollow scraper (see Pl. xiii., fig. 10), a broken spear-head of flint, an arrow-head of flint, 107 flakes of chert, and 30 of flint, hammer-stones, anvil-stones, pottery, and bones. The chert objects are much more numerous than those made of flint. About three-fourths of the entire are of chert. This material is quite black, with a clean, smooth, shiny fracture. Most of the objects made from it are small, some being much smaller than flint implements of the same class. Some of the scrapers are only half an inch in diameter. Two of these are shown full size in figs. 8 and 11 in Plate xiii. The place where the implements are found in greatest quantity is on the face of a hill alongside the sand-hills, and near a large carn, which is partly demolished. In other sand-hills we found the implements in greatest abundance around the hut-sites where the

people had evidently sat and worked; but here, where the implements were plentiful, there was no appearance of black layers or signs like what I had seen elsewhere of hut-sites. It was supposed that the neighbourhood of the carn might have some connexion with this unusual distribution of the implements; but on my last visit, I found out clearly that the carn had not necessarily anything to do with the matter, and that the position of the implements was due to an entirely different cause. All along the face of the hill where the implements are found the carboniferous limestone comes to the surface, and has undergone so much decomposition that the nodules of chert which it contained are liberated and lying on the surface. The prehistoric people, finding this abundant supply of chert, sat down among the precious material and carried on their manufacture on the spot. Their hut-sites were lower down among the sand-hills, where I have found the usual old surface with flakes of chert and shells. I procured some hammer-stones and anvil-stones, a piece of a polished stone hatchet, and some bits of pottery. Plate XIII. shows a series of objects from Bundoran—fig. 1 is a chert arrow-head; 2 is a partly-finished arrow-head of chert; 4 and 6 are flint arrow-heads; 5 is a chert flake, dressed entirely over the back, but undressed on the flat side, which is not shown; 7 is a borer of chert; and 9 is part of a large spear-head of flint, which may have been about 4 inches long. A scraper, combining both the ordinary and hollow scrapers already referred to, is shown in fig. 10 of same plate. Fig. 12 is a knife of flint broken at the point; and 8 and 11 are small scrapers of chert. An anvil-stone, with two indented spaces on one face, is shown in Pl. XII., fig. 8.

Stredagh.

The last place I examined was Stredagh, near Grange, in county of Sligo. I found several hut-sites in the sand-hills there with old floors and surfaces full of sea-shells. I saw no flint objects, but found two hammer-stones, an anvil-stone, a quartz core or pebble, from which it had been attempted to strike flakes, and a portion of the top of a quern. The various implements, the old surface with included shells, and the hut-sites, were in every way similar in character to the corresponding remains in other sand-hills.

Conclusion.

Before concluding this report it is necessary to mention that articles of bronze and iron, glass and porcelain beads, and even coins, have been found in several of the sand-hills. I have three bronze pins and a small ring of bronze which were obtained in different sand-hills. Two of the pins and the ring were found on the surface, and the other pin was obtained while pulling bent. The Rev. Mr. Hassé found a bronze pin also on the surface at Whitepark Bay, a curious brooch of bronze at Portstewart, and several fragments of bronze and iron at Grangemore. Several coins have been found at Portstewart, and I found myself a coin of Queen Elizabeth at Dundrum, and a halfpenny of Queen Victoria at Portstewart. Such finds have caused some of my archæological friends to look on the flint implements as belonging to a comparatively late period, so late as to be, at least, contemporary with iron objects. I am quite willing to admit anything that is fairly proved; but, as yet, I have seen no evidence that metal of any kind was used conjointly with the flint tools. The old surface is the test for contemporaneousness. Whatever is dug out of it must have been in use at the same time, and any implements lying loose on the surface, similar to those contained in the old surface, must be classed with them. But there have also been found lying on the present surface among the worked flints grains of shot, cartridge cases, scraps of iron, such as nails, broken bottles, portions of old shoes, and stray coins of late date. My friends would not think of making the flint implements contemporary with any of these objects, and yet they have been found enjoying as favoured positions among the flints as were occupied by any of the bronze pins or other articles of either bronze or iron. I have dug over many portions of old surface in the various sand-hills, sometimes finding it rich in remains and sometimes poor; but I never yet met with a scrap of metal of any kind, nor have I heard of anyone finding metal in it, though, now that there is so much of a thoroughfare over the various stations I have mentioned, it would not be surprising if some modern articles were trampled into the old surface where it is exposed, and turn out a stumbling-block to some archæologists. Finds of metal, if ever such take place, should be thoroughly investigated and verified. My theory as to the accumulation of sand on the old surface has been several times stated. That the sand was heaped up slowly, just in proportion to the power of the grassy sward to protect and retain the sand blown on by the wind, is, I believe, the

true explanation. During the accumulation of many feet of sandy covering, the surface would become a little higher every year, and many an object might be dropped in passing over the hills which would become, in a short time, buried up; but this, if the entire covering was at a later time blown away, would drop down to the level of the old surface and appear among the flints. We learn, too, from old inhabitants, that many years ago the sand-hills, in some parts, were occupied by smugglers and illicit distillers. At Craigmore, the place was pointed out to me where they had a hut in the sand, and carried on the process of distillation. In this case many things would, no doubt, be left behind to confuse investigators. Again, we find that it was a custom among those who practised cremation to bury in sand-hills. Possibly it was because they were in the form of mounds, and not because they were composed of sand. I can point to many cases in the neighbourhood of Ballymena where sepulchral urns have been found close to the surface in natural sandhills. This practice of burying on mounds extended to other countries. In England we have frequent mention of secondary interments on barrows, and on the Continent we find there was a desire to bury on former sepulchral mounds. Engelhardt says it is a remarkable fact that urns have very frequently been buried in the sides of barrows belonging to the preceding or stone age.[1] I have no doubt that the rounded hillocks of sand in the sandhills would be selected as places for depositing urns, and in cases where the sandy covering would be carried away by the wind, an urn with its contents would fall down and become mingled with the flint implements of an earlier date. I am of opinion that the presence of bronze pins, and some other objects, found in the sand-hills may be accounted for in this way.

In all the stations I have mentioned the people seemed to have an instinct for working in stone. They wrought almost any material that came in their way: flint, if it could be had, but if not, then any hard rock that occurred in the district. At Whitepark Bay, where one would have expected that, owing to flint being so plentiful, they would have confined themselves to that material, we find that they wrought the altered lias, and even made cutting implements of the hardened chalk. At Portstewart and Dundrum they used several substances besides flint. At Dunfanaghy they used quartzite; at Bundoran chert; and at Stredagh we find how they have practised on a rather untractable pebble of quartz. I have seen no evidence that

[1] *Denmark in the Early Iron Age*, p. 2.

any one set of occupiers, or tribe, ever tried to procure some of the better material in possession of any of their neighbours. Let the stone be good or bad, it appears to me that they just wrought what they had. The finding of flint so far away from its source was, I thought, an indication of commercial relations; but I think another explanation may be given of that. In all the various stations, though the material used for weapons may be different, yet the weapons themselves were of the same kinds. The people seem to have had in every case similar habits, and to have used the same kinds of food. It does not seem to me that they were in the presence of a people of superior culture who had bronze or iron weapons. On the contrary, I believe they were masters in the country, and had perfect freedom to hunt the red deer, the wild boar, and other animals.

Inside the boundary I have taken in we find flint implements most abundant in Antrim. They are found also in Derry and Down, and I have several good flint implements and flakes from Tyrone. They are also found in Fermanagh, and G. H. Kinahan has got flakes and implements in Donegal. Colonel Wood-Martin has found flakes of Antrim flint in the stone graves which he has excavated at Carrowmore. But did the people of the sand-hills penetrate inland, or was it a stone-age people of superior culture who came afterwards, and occupied the centre of our island? Worsaæ says that the people of the early stone age in Denmark, by which he means the people who lived on the coast, and whose remains we find in kitchen middens, came from the coast of the Atlantic and North Sea, and that people of a later stone age came afterwards, who had domestic animals, made finer implements, and erected large stone graves for their dead. This theory is of course questioned, but I believe at the first dawn of the Neolithic period the coast would be the natural road by which the first people would advance. Did the first wave of Neolithic people come from the southward, along the coast of France, and occupy the coasts of Denmark and the British Isles? That is a question which I think further investigation of the sand-hills may help to solve. The mode of life and implements of the Danish and Irish coast-dwellers seem to have been so similar, that I believe them to have been the same people. A bronze pin has been found in some Scotch kitchen middens, and consequently some look on such articles as not being older than 800 or 900 A.D.[2]; but there are so many ways by which metal objects could have been introduced, that I should like to have

[2] *Prehistoric Times*, by Sir John Lubbock, 4th ed., p. 234.

some confirmatory evidence before accepting the age of the middens in question to be of so recent a date. No doubt descendants of the people of the kitchen middens may have continued to exist in the old way in small islands and less favoured spots after the introduction of a superior culture, but, as regards the stations I have reported on, no intermediate layer, with relics, occur in the many feet of sandy covering we sometimes see above the layer containing the flint implements, and therefore I believe that when the superior culture did come the flint-workers of the coasts were either absorbed or exterminated, and the sand-hills ceased to be occupied as dwelling-places.

XIX.

REPORT ON FLINT IMPLEMENTS OF THE NORTH-EAST OF IRELAND. By W. J. KNOWLES.

[Read January 14, 1889.]

In former communications to the Academy[1] I have shown grounds for there being two series of flint implements in Ireland. On further research I see no reason to depart from the decision I had come to on the occasions referred to. The implements of the older series, which are the subject of the present report, are found embedded in an aqueous deposit known as the raised beach, often many feet from the surface. The worked flints of the series consist chiefly of flakes and cores; but we find, in addition to these, pear-shaped implements, not flat, but rather rudely circular in section, and others longish coarsely dressed, somewhat pointed at both ends, and often triangular in section. While a few of the implements have been found in the aqueous deposit itself, many have been obtained from the material spread out on the shore in cases where the raised beach has suffered denudation. Some of the implements approach the palæolithic type, but others show a different form. Such animal remains as have been found in association with the worked objects are insufficient for determining their age, but there is sufficient evidence to show that they are older than the ordinary flint implements of Ireland, such, for instance, as are to be found in the Academy's Museum, and therefore I shall content myself for the present by continuing to speak of them as the older series.

In the raised beach at Larne the flakes and cores are to be found as low as eighteen feet from the surface. We would, no doubt, find them at a lower level, but that is about the greatest depth to which any section has been opened. They are covered with a whitish weathered crust, in some cases three-eighths of an inch in thickness, and in several cases I have obtained flakes and cores *in situ* at various

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[1] *Proceedings*, 2nd Ser., vol. ii., p. 209, and p. 436 (Pol. Lit. and Antiq.).

depths, showing that they had been weathered and rolled about so as to break the porcelaneous glaze, and wear away some of the crust previous to being included in the deposit which makes up the raised beach, and therefore they must be considerably older than the deposit in which they are embedded. The raised beach containing the worked flints extends from Larne round the shores of Belfast Lough, and it is also to be found northwards from Larne. It is seen at the Giant's Causeway, and implements of a similar kind to those from Larne are found on the shore at Whitepark Bay. Belfast Lough and Larne seem rather to have been a centre from which flints of this older series drifted southwards, as I have found them at Dundrum, Malahide, and some other stations, in many cases wrought into newer implements by the people who worked in stone among the sand-hills. At Dundrum, the Causeway, and other parts, the sand-hills containing remnants of the old surface and flint implements rest on the raised beach containing flakes and cores of the older series. At Larne there are excellent sections, and the method of investigation which I employed was to take a band at a particular depth, clear away the loose matter on the face, and work inward to the undisturbed material. In this way I have obtained many worked flints *in situ* at depths of six to eighteen feet. I now beg to present a representative series to the Academy.

NOTE ADDED IN THE PRESS.

Some months ago a mammoth's tooth was found by Dr. Moran, H. M. Inspector of Schools, in the gravel beds of the raised beach at Larne in association with the worked flints. The tooth was exhibited, and an account of the find read by Dr. Moran to the Belfast Nat. Hist. and Philosophical Society, on 5th February, 1889.

XX.

ON THE HARMONIC TIDAL CONSTITUENTS OF THE PORT OF DUBLIN. BY SIR ROBERT S. BALL, Royal Astronomer of Ireland.

[Read DECEMBER 10, 1888.]

IN the recent edition of the Admiralty Manual of Scientific Inquiry, Professor G. H. Darwin has described and illustrated by an example a convenient method of determining the chief Harmonic Tidal Constituents, from a series of observations of the height of the water taken every hour for 720 consecutive hours. For the explanation of the process, reference must be made to the work referred to.

As an exercise in this method, I have investigated the tides in our own port. By the kindness of the Secretary of the Port and Docks Board, and of their Engineer, Mr. Stoney, and his assistant, Mr. Griffith, I was permitted to have access to the admirable series of automatic tidal records which have been taken at the North Wall for many years. I selected for my purpose the observations made in May and June, 1887.

The first operation was to read off from the curves traced by the machine the height of the water at each hour for 720 consecutive hours. As the epoch for commencing, I took noon, on May 28th, 1887, when the height of the water was 7·4 feet. The results of the reading are shown on the sheet S, where, for convenience, I have omitted the decimal points. For example, on the 13th June, at 17^h we find the figures 106. This means that at 5 A.M. on the 14th June, in civil time, the tide-gauge showed the water stood at 10·6 feet above a certain arbitrary level taken as the zero. Allowance has been made for barometric pressure at the rate of a foot of height per inch of mercury. The standard I took was 30 inches; but this is immaterial.

The several sheets S, O, M are then prepared in accordance with the rules for harmonic analysis. This is conducted by General Strachey's method, and the final results, using the language of the harmonic notation, are as follows:—

TIDES.		$A_0 = 7{\cdot}06.$
Lunar Semidiurnal, ...	M_2	$\begin{cases} H_m = 4{\cdot}38, \\ \kappa_m = 314^\circ. \end{cases}$
Solar Semidiurnal, ...	S_2	$\begin{cases} H_s = 1{\cdot}21, \\ \kappa_s = 356^\circ. \end{cases}$
Lunisolar Semidiurnal, ...	K_2	$\begin{cases} H'' = {\cdot}330, \\ \kappa'' = 356^\circ. \end{cases}$
Lunisolar Diurnal, ...	K_1	$\begin{cases} H' = {\cdot}283, \\ \kappa' = 164^\circ. \end{cases}$
Solar Diurnal, ...	P	$\begin{cases} H_p = {\cdot}094, \\ \kappa_p = 164^\circ. \end{cases}$
Lunar Diurnal, ...	O	$\begin{cases} H_o = {\cdot}365, \\ \kappa_o = 4^\circ. \end{cases}$

The sheets S, O, M, and the four harmonic reductions, are here appended.

1887.	Day.	0h.	1.	2.	3.	4.	5.	6.	7.	8.
May 28, . . .	0d	74	90	105	109	102	88	65	42	28
,, 29, . . .	1	54	74	91	105	109	104	89	67	46
,, 30, . . .	2	36	52	71	87	100	106	102	80	68
,, 31, . . .	3	20	31	47	67	85	99	108	106	94
June 1, . . .	4	21	18	28	45	67	85	103	111	109
,, 2, . . .	5	34	14	13	24	43	67	88	105	115
,, 3, . . .	6	58	30	9	9	25	47	73	95	113
,, 4, . . .	7	87	59	28	8	13	28	53	80	102
,, 5, . . .	8	111	86	52	19	9	14	33	60	89
,, 6, . . .	9	124	108	78	45	16	11	21	45	74
,, 7, . . .	10	127	121	101	71	44	20	19	32	56
,, 8, . . .	11	119	120	111	92	61	35	16	20	36
,, 9, . . .	12	106	117	117	106	83	58	33	21	27
,, 10, . . .	13	85	100	109	108	97	77	53	32	28
,, 11, . . .	14	70	88	101	108	103	92	72	52	38
,, 12, . . .	15	57	71	87	97	102	99	89	70	52
,, 13, . . .	16	45	57	70	85	96	100	98	87	70
,, 14, . . .	17	36	44	57	71	84	94	100	97	87
,, 15, . . .	18	34	36	46	57	71	83	95	100	97
,, 16, . . .	19	42	34	35	45	58	72	88	99	103
,, 17, . . .	20	54	38	30	33	45	59	77	91	104
,, 18, . . .	21	70	49	31	27	32	48	68	85	101
,, 19, . . .	22	88	62	40	23	25	37	55	77	93
,, 20, . . .	23	101	80	53	30	22	29	44	67	89
,, 21, . . .	24	113	98	70	43	22	21	32	53	76
,, 22, . . .	25	119	108	86	59	31	17	21	37	61
,, 23, . . .	26	118	116	102	77	48	22	18	25	45
Sum,	..	2003	1901	1768	1650	1593	1612	1713	1845	2001
Divisor,	..	27	..	..	..	..	..	..	..	..
Mean,	..	742	704	655	611	590	596	634	683	741
June 24, . . .	27	112	119	113	98	70	42	21	19	31
,, 25, . . .	28	100	115	119	108	89	62	36	22	25
,, 26, . . .	29	84	101	112	113	101	82	58	34	22
Sum,	..	2299	2236	2112	1949	1853	1798	1828	1920	2079
Divisor,	..	30	..	..	..	..	..	..	..	..
		766	745	704	649	618	599	609	640	693

11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
58	76	91	105	113	109	97	75	62	29	19	23
42	58	74	88	103	110	109	98	78	55	32	20
33	41	55	71	87	101	111	110	99	81	58	35
37	31	38	50	68	86	100	111	113	104	87	61
53	33	28	33	49	68	87	102	114	115	106	87
75	50	27	20	26	44	66	86	103	116	118	107
97	72	45	20	16	26	47	72	93	111	124	124
118	99	70	39	15	14	25	48	75	97	116	126
136	116	96	62	31	10	14	27	50	78	99	117
129	129	115	89	55	25	10	15	31	58	84	105
123	128	127	108	78	48	19	8	18	37	62	87
109	123	128	120	103	72	44	19	16	22	43	67
88	106	117	119	109	90	63	38	19	17	26	45
72	91	107	118	117	106	86	62	39	22	23	35
60	79	93	109	114	113	102	80	59	38	27	30
49	65	80	93	105	110	107	97	79	59	40	32
44	50	65	78	90	100	106	103	94	77	58	41
46	44	51	62	75	88	98	104	103	92	77	59
54	43	40	48	60	73	88	99	104	103	93	78
69	52	41	39	48	61	77	90	101	107	103	92
86	64	47	36	37	48	62	80	94	105	110	105
99	80	59	37	28	32	48	66	82	99	109	111
111	96	72	47	25	23	32	50	72	91	105	113
120	110	91	63	34	20	22	37	56	81	100	113
122	119	104	79	51	23	16	21	39	63	87	104
119	124	116	99	69	40	16	14	22	43	70	91
111	123	124	112	90	60	29	12	15	28	51	77
2250	2202	2101	1944	1796	1700	1681	1724	1820	1928	2027	2085
..	..	..	..	..	..	..	..	..	..	..	..
833	816	778	720	665	630	623	639	674	714	751	772
99	114	124	122	107	81	52	24	12	16	33	55
186	103	118	123	147	102	73	47	20	12	18	37
64	86	101	115	120	111	98	69	44	20	13	21
2499	2505	2444	2304	2140	1994	1904	1864	1896	1976	2091	2198
..	..	..	..	..	..	..	..	..	..	..	..
833	835	815	768	713	665	635	621	632	659	697	733

Sheet O.]

1867.	Day.	0h.	1.	2.	3.	4.	5.	6.	7.	8.	9.
May 28, . . .	0	74	90	105	109	102	88	65 42·	28	30	[illegible]
,, 29, . . .	1	91	105	109	104	89	67	46	33	33 42·	[illegible]
,, 30, . . .	2	100	106	102	89	68	49	35	33	41	[illegible]
,, 31, . . .	3	99 108·	106	94	75	53	37	31	38	50	[illegible]
June 1, . . .	4	111	109	97 76·	53	33	28	33	49	68	[illegible]
,, 2, . . .	5	113	99	75	50	27	20 26·	44	66	86	[illegible]
,, 3, . . .	6	97	72	45	20	16	26	47	72 93·	111	[illegible]
,, 4, . . .	7	70	39	15	14	25	48	75	97	116	[illegible]
,, 5, . . .	8	31	10	14	27	50	78	99	117	128	[illegible]
,, 6, . . .	9	25	10 15·	31	58	84	105	120	127	121	[illegible]
,, 7, . . .	10	8	18	37	62	87 105·	119	120	111	92	[illegible]
,, 8, . . .	11	22	43	67	89	106	117	117 106·	83	58	[illegible]
,, 9, . . .	12	45	68	85	100	109	108	97	77	53 32·	[illegible]
,, 10, . . .	13	70	88	101	108	103	92	72	52	38	[illegible]
,, 11, . . .	14	71 87·	97	102	99	89	70	52	41	40	[illegible]
,, 12, . . .	15	85	96	100 98·	87	70	56	44	44	50	[illegible]
,, 13, . . .	16	94	100	97	87	71	56 46·	44	51	62	[illegible]
,, 14, . . .	17	100	97	87	70	54	43	40	48 60·	73	[illegible]
,, 15, . . .	18	100	88	69	52	41	39	48	61	77	[illegible]
,, 16, . . .	19	86	64	47	36	37	48	62	80	94	[illegible]
,, 17, . . .	20	80	59 37·	28	32	48	66	82	99	109	[illegible]
,, 18, . . .	21	47	25	23	32 50·	72	91	105	113	113	[illegible]
,, 19, . . .	22	20	22	37	56	81	100	113 120·	113	98	[illegible]
,, 20, . . .	23	21	39	63	87	104	117	119	108	86 59·	[illegible]
,, 21, . . .	24	43	70	91	109	118	116	102	77	48	[illegible]
Sum,	..	1898	1772	1895	1755	1842	1856	2080	1971	2008	[illegible]
Divisors,	..	27	27	27	26	26	27	28	27	28	[illegible]
Means,	..	703	656	702	675	708	687	743	730	717	[illegible]

11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
76	91	105	113	109	97	75	52	29 19·	23	38	51	74
88	103	110	109	98	78	55	32	20	22	36	52 71·	87
87 101·	111	110	99	81	58	35	18	20	31	47	67	85
100	111	113 104·	87	61	38	21	18	28	45	67	85	103
114	115	106	87	60	34 14·	13	24	43	67	88	105	115
118	107	87	58	30	9	9	25 47·	73	95	113	119	115
109	87	59	28	8	13	28	53	80	102 118·	125	118	99
86	52	19	9	14	33	60	89	109	123	126	116	96 62·
78	45 16·	11	21	45	74	98	116	129	129	115	89	55
44	20	19	32 56·	83	105	123	128	127	108	78	48	19
16	20	36	61	88	109	123 128·	120	103	72	44	19	16
27	43	66	88	106	117	119	109	90 63·	38	19	17	26
51	72	91	107	118	117	106	86	62	39	22	23 35·	51
60 79·	93	109	114	113	102	80	59	38	27	30	·42	57
80	93	105 110·	107	97	79	59	40	32	33	45	57	70
90	100	106	103	94 77·	58	41	32	36	44	57	71	84
98	104	103	92	77	59	42	34 36·	46	57	71	83	95
104	103	93	78	59	42	34	35	45	58 72·	88	99	103
103	92	74	54	38	30	33	45	59	77	91	104	108 100·
105	90 70·	49	31	27	32	48	68	85	101	110	110	99
88	62	40	23 25·	37	55	77	93	109	114	111	96	72
53	30	22	29	44	67	89 104·	116	120	110	91	63	34
22	21	32	53	76	97	112	122	119 104·	79	51	23	16
21	37	61	86	104	119	124	116	99	69	40 16·	14	22
25 45·	70	92	111	123	124	112	90	60	29	12	15	28
2068	1958	2032	1861	1867	1760	1948	1803	1947	1882	1731	1795	1891
28	27	27	27	26	26	27	27	28	27	26	27	27
739	725	753	689	718	677	721	668	695	697	666	665	700

1887.	Day.	0h.	1.	2.	3.	4.	5.	6.	7.	8.	
May 28, . . .	0	74	90	105	109	102	88	65	42	28	
,, 29, . . .	1	74	91	105	109	104	89	67	46	33	
,, 30, . . .	2	71	87	100	106	102	89	68	49	35	
,, 31, . . .	3	67	85	99	108	106	94	75	53	37	
June 1, . . .	4	45	67	85	103 111·	109	97	76	53	33	
,, 2, . . .	5	43	67	88	105	115	113	99	75	50 27·	
,, 3, . . .	6	47	73	95	113	119	115	97	72	45	
,, 4, . . .	7	53	80	102	118	125	118	99	70	39	
,, 5, . . .	8	60	89	109	123	126	116	96	62	31	
,, 6, . . .	9	74	98	116	129	129	115	89	55	25	
,, 7, . . .	10	56	83	105 123·	128	127	108	78	48	19	
,, 8, . . .	11	61	88	109	123	128	120	103	72· 44	19	
,, 9, . . .	12	66	88	106	117	119	109	90	63	38	
,, 10, . . .	13	72	91	107	118	117	106	86	62	39	
,, 11, . . .	14	79	93	109	114	113	102	80	59	38	
,, 12, . . .	15	80	93	105	110	107	97	79	59	40	
,, 13, . . .	16	65	78 90·	100	106	103	94	77	58	41	
,, 14, . . .	17	62	75	88	98	104	103 92	77	59	42	[illegible]
,, 15, . . .	18	60	73	88	99	104	103	93	78	59	[illegible]
,, 16, . . .	19	61	77	90	101	107	103	92	74	54	[illegible]
,, 17, . . .	20	62	80	94	105	110	105	90	70	49	31
,, 18, . . .	21	66	82	99	109	111	102	88	62	40	23
,, 19, . . .	22	72	91	105	113	113	101	80	53	30	22
,, 20, . . .	23	56	81	100	113	120 113·	98	70	43	22	21
,, 21, . . .	24	63	87	104	117	118	108	86	59	31 17·	21
,, 22, . . .	25	70	91	109	118	116	102	77	48	22	18
,, 23, . . .	26	77	98	112	119	113	98	70	42	21	19
,, 24, . . .	27	82	100	115	119	108	89	62	36	22	25
Sums,	..	1818	2466	2972	3261	3289	2974	2309	1666	1026	680
Divisors,	..	28	29	29	29	29	29	28	29	30	28
Means,	..	649	850	1025	1124	1134	1026	824	574	342	243

..	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
58	76	91	105 113·	109	97	75	52	29	19	23	38	54
58	74	88	103	110	109	98	78 55·	32	20	22	36	52
55	71	87	101	111	110	99	81	58	35	18	20	31 47·
50	68	86	100	111	113	104	87	61	38	21	18	28
49	68	87	102	114	115	106	87	60	34	14	13	24
44	66	86	103	116	118	107	87	58	30	9	9	25
26	47 72·	93	111	124	124	109	87	59	28	8	13	28
25	48	75	97	116	126	126 111·	86	52	19	9	14	33
27	50	78	99	117	128	124	108	78	45	16 11·	21	45
31	58	84	105	120	127	121	101	71	44	20	19	32
37	62	87	105	119	120	111	92	61	35	16	20	36
43	67	89	106	117	117	106	83	58	33	21	27	43
26 45·	68	85	100	109	108	97	77	53	32	28	33	51
35	51	70	88	101	108 103·	92	72	52	38	35	43	60
42	57	71	87	97	102	99	89	70	52 41·	40	49	65
45	57	70	85	96	100	98	87	70	56	44	44	50
44	57	71	84	94	100	97	87	71	56	46	44	51
46	57	71	83	95	100	97	87	70	54	43	40	48
45	58	72	88	99	103	100	88	69	52	41	39	48
33	45	59	77 91·	104	108	100	86	64	47	36	37	48
32	48	68	85	101	110	110	99	80 59·	37	28	32	48
37	55	77	93	109	114	111	96	72	47	25	23	32 50
44	67	89	104	116	120	110	91	63	34	20	22	37
53	76	97	112	122	119	104	79	51	23	16	21	39
61	86	104	119	124	116	99	69	40	16	14	22	43
45	70	92 111·	123	124	112	90	60	29	12	15	28	51
52	77	99	114	124	122	107 81·	52	24	12	16	33	55
62	86	103	118	123	117	102	73	47	20	12	18 37·	60
1250	1842	2440	3001	3122	3266	3091	2376	1661	1009	667	813	1314
29	29	29	30	28	29	30	29	29	29	29	29	30
431	635	841	100	1115	1126	103	819	573	348	230	280	438

Harmonic Analysis for Semidiurnal Component of Means from 30 Days on Sheet S.

I.		II.		IX.	X.	XI.	XII.	XIII.	XIV.	XV.
Hours.	Hourly Values 0 to 11.	Hours.	Hourly Values 12 to 23.	I. + II.	Second half of IX.	IX. − X.	Second half of XI.	XI. − XII., omitting top entry of XII.	XI. + XII., omitting top entry of XI.	IX. + X.
0	7·66	12	8·35	16·01	12·30	+ 3·71	− 0·86	+ 3·71	− 0·86	28·31
1	7·45	13	8·15	15·60	12·72	+ 2·88	− 2·49	+ 5·37	+ ·39	28·32
2	7·04	14	7·68	14·72	13·52	+ 1·20	− 3·56	+ 4·76	− 2·36	28·24
3	6·49	15	7·13	13·62	14·48	− 0·86		Sum, .. 13·84	Sum, .. − 2·83	28·10
4	6·18	16	6·65	12·83	15 32	− 2·49		× ·067	× ·067	28·15
5	5·99	17	6·35	12·34	15·90	− 3·56		$A_2 = + 0·9273$	$B_2 = − 0·1896$	28·24
								$A_2 +$, $B_2 −$ ζ_s in 4th Quadrant.		Sum, .. 169·36
										÷ 24
										$A_0 = 7·057$
6	6·09	18	6·21	12·30						
7	6·40	19	6·32	12·72						
8	6·93	20	6·59	13·52						
9	7·51	21	6·97	14·48						
10	7·99	22	7·33	15·32						
11	8·33	23	7·57	15·90						

$\text{Log } B_2 = 9·27784\,(n)$ $\quad$ $\text{Log sec } \zeta_s = ·00888$

$\text{Log } B_2 = 9·96722$ $\quad$ $\text{Log } A_2 = 9·96722$

$\text{Log tan } \zeta_s = 9·31062\,(n)$ $\quad$ $\text{Log } R_s = 9·97610$

$\zeta_s = 360° − 11° 33'$ $\quad$ $R_s = ·9465$

HARMONIC ANALYSIS FOR DIURNAL COMPONENT OF ...

I.		II.		III.	IV.	V.	VI.	VII.	VIII.
Hours.	Hourly Values 0 to 11.	Hours.	Hourly Values 12 to 23.	I. — II.	Middle Four of III. with Opposite Sign.	Last Four of III.	III. + IV. + V.	See III., IV., and V.	See III., IV., and V.
0	7·42	12	8·16	(a) − ·74	+ ·40	+ ·27	(c) − ·07	M − 2·60	M − 2·60
1	7·04	13	7·78	− ·74	+ ·27	+ ·40	(d) − ·07	− N − 1·83	N + 1·83
2	6·55	14	7·20	− ·65	+ ·05	+ ·48	(e) − ·12	(a) − ·74	(b) − ·05
3	6·11	15	6·65	Sum, . . − ·54	− ·09	+ ·59	(f) − 0·4	$\frac{1}{3}\alpha$ − ·03	$-\frac{1}{3}\beta$ + ·08
4	5·90	16	6·30	− ·40				Sum, . . . − 5·20	Sum, . . . − 0·74
5	5·96	17	6·23	− ·27	$\alpha = (c) + (d) - (f) = -\ ·10$			× ·0658	× ·0658
				$M = -\ 2·60$	$\beta = (d) + (e) + (f) = -\ ·23$			$A_1 = -$ ·342	$B_1 = -$ ·049
								A_1 − B_1 − ζ' lies in 3rd Quadrant.	
6	6·34	18	6·39	(b) − ·05					
7	6·83	19	6·74	+ ·09	Log B_1 = 8·6902 n			Log sec ζ' = ·0044 n	
8	7·41	20	7·14	+ ·27	Log A_1 = 9·5340 n			Log A_1 = 9·5340 n	
9	7·91	21	7·51	Sum, . . + ·40	Log tan ζ' = 9·1562			Log R' = 9·5384	
10	8·20	22	7·72	+ ·48	ζ' = 188° 9′			R' = + ·345	
11	8·33	23	7·74	+ ·59					
				$N = +\ 1·83$					

Harmonic Analysis for Diurnal Component of Means on Sheet ●.

I.		II.		III.	IV.	V.	VI.	VII.	VIII.
Hours.	Hourly Values 0 to 11.	Hours.	Hourly Values 12 to 23.	I. − II.	Middle Four of III. with Opposite Sign.	Last Four of III.	III. + IV. + V.	See III., IV., and V.	See III., IV., and V.
0	7·03	12	7·25	(a) − ·22	− ·31	+ ·20	(c) − ·33	M − 1·30	M − 1·30
1	6·56	13	7·53	− ·97	+ ·34	+ ·85	(d) + ·22	− N − 2·78	N + 2·78
2	7·02	14	6·89	+ ·13	− ·75	+ ·99	(e) + ·37	(a) − ·22	(b) + ·75
3	6·75	15	7·18	Sum, . . − ·43	− ·35	+ ·39	(f) − ·39	$\frac{1}{2}\alpha$ + ·09	− $\frac{1}{2}\beta$ − ·07
4	7·08	16	6·77	+ ·31				Sum, . . . − 4·21 × ·0658 A_1 = − 0·277	Sum, . . . + 2·16 × ·0658 B_1 = + 0·142
5	6·87	17	7·21	− ·34	$\alpha = (c) + (d) - (f) = + \cdot 28$				
				M = − 1·30	$\beta = (d) + (e) + (f) = + \cdot 20$			A_1 − B_1 + ζ_0 in 2nd Quadrant.	
6	7·43	18	6·68	(b) + ·75					
7	7·30	19	6·95	+ ·35					
8	7·17	20	6·97	+ ·20					
9	7·51	21	6·66	Sum, . . + ·85					
10	7·64	22	6·65	+ ·90					
11	7·39	23	7·00	+ ·39					
				N = + 2·78					

Log B_1 = 9·1523 Log sec ζ_0 = 0·0506 n

Log A_1 = 9·4425 n Log A_1 = 9·4425 n

Log tan ζ_0 = 9·7098 n Log 1·0029 = ·0013

$\zeta_0 = \pi - 27° 9'$ Log R_0 = 9·4944

= 152°·9 R_0 = 0·312

HARMONIC ANALYSIS FOR SEMIDIURNAL COMPONENT OF [illegible]

I.		II.		IX.	X.	XI.	XII.	XIII.	XIV.	XV.
Hours.	Hourly Values 0 to 11.	Hours.	Hourly Values 12 to 23.	I. + II.	Second half of IX.	IX. − X.	Second half of XI.	XI. − XII., omitting top entry of XII.	XI. + XII., omitting top entry of XI.	IX. + X.
0	6·49	12	6·35	12·84	16·43	− 3·59	+ 17·66	− 3·59	+ 17·66	29·27
1	8·50	13	8·41	16·91	11·47	+ 5·44	+ 16·91	− 11·47	+ 22·35	28·38
2	10·25	14	10·00	20·25	6·90	+ 13·35	+ 11·87	+ 1·48	+ 25·22	27·15
3	11·24	15	11·15	22·39	4·73	+ 17·66		Sum, .. − 13·58	Sum, .. + 65·23	27·12
4	11·34	16	11·26	22·60	5·69	+ 16·91		× ·067	× ·067	28·29
5	10·26	17	10·30	20·56	8·69	+ 11·87		$A_2 = -$ ·911	$B_2 = +$ 4·37	29·25
								$A_2 -$, $B_2 +$ ζ_m in 2nd Quadrant.		Sum, .. 169·46 ÷ 24 $A_0 = 7·061$
6	8·24	18	8·19	16·43						
7	5·74	19	5·73	11·47						
8	3·42	20	3·48	6·90						
9	2·43	21	2·30	4·73						
10	2·89	22	2·80	5·69						
11	4·31	23	4·38	8·69						

$\text{Log } B_2 = \cdot 64048$

$\text{Log } A_2 = 9\cdot 95952\,(n)$

$\text{Log tan } \zeta_m = 0\cdot 68096$

$\zeta_m = \pi - 78^\circ\, 13'$

$\text{Log cosec } \zeta = \cdot 00924$

$\text{Log } B_2 = \cdot 64048$

$\cdot 0050$

$\text{Log } R_m = \cdot 65472$

$R_m = 4\cdot 516$

XXI.

ON FILARIA SANGUINIS HOMINIS. By BRIGADE-SURGEON C. SIBTHORPE, F.K.Q.C.P., Professor of Surgery, Madras Medical College. (Plate XIV.)

[Read January 28, 1889.]

The life-history of this form of Filaria is of great interest, especially to medical men in Africa, India, Ceylon, Straits Settlements, China, Australia, the Pacific, and South America, as certain forms of hæmaturia, cyluria, elephantiasis, lymphs-scrotum, with other forms of lymphatic obstruction, and the disease known in Africa as "craw-craw" appear to be connected with its presence and development in the human body.

In the year 1866 embryos of this worm were discovered by means of the microscope in the urine in cases of hæmaturia: in 1872 the late Professor Lewis of Calcutta connected these with the embryos which he discovered in the human blood. In 1876 both he and Dr. Bancroft, of Brisbane, discovered the mature female worm. Lewis succeeded in finding a portion of the male worm, minus its caudal extremity, which he describes in the *Quarterly Journal of Microscopical Science*, 1879.

The female worm has since been found by Dr. Manson, at Amoy, China, and Dr. Silva, at Aranjo and Los Santos. Since then Dr. Bancroft suggested, and Dr. Manson discovered, that the intermediary host of this worm was a peculiar form of mosquito (Culex), the female of which alone is provided with a proboscis, which permits of the entrance of the embryos. He also noted that the number sucked by the mosquito was greater than existed in an equal quantity of blood removed from the skin by a prick. The same fact has been found by the writer in Madras to be the case regarding bugs which had fed on the blood of patients which contained the embryos of Filaria.

Dr. Mason in his work on *Filaria sanguinis hominis*, published by H. K. Lewis in 1883, describes graphically his experiments regarding the development of the embryos in the mosquito, and how the new worm gets into drinking water on the death of its host.

The worm having been swallowed from drinking water appears to

make its way to the lymphatic system, where both males and females reside and conjugate; numerous embryos are the result; and these appear to travel from the lymphatic system, where they are constantly found, into the blood stream, where they are as a rule only seen at night or during rest; this is known as "filaria periodicity."

An interesting experiment was made, in which a patient whose blood had been proved to contain embryos discoverable only at night had his habits changed, and was kept awake at night and allowed to sleep during the day. The movements of the embryos were found to have changed with this alteration in the habits of the patient, and they were only remarked in the blood during the daytime, and not at night. These experiments were repeated and confirmed by different observers.

The most favourable time for finding the embryos is between 6 p.m. and 6 a.m., the maximum number being generally observed about midnight: this Manson first pointed out. Observations in the Madras General Hospital and elsewhere have confirmed the fact.

Mr. Mortimer Granville has advanced a theory that this periodicity is due to the conditions of the circulation and chyle currents that accompany sleep.

Manson's idea is that these embryos block up the capillaries or smaller lymphatics, and that this causes obstruction in the stream, which is followed by rupture, leading in some cases to a flow of lymph, effusions of lymph, hypertrophy, and occasionally hæmorrhages.

The presence of the embryos has been demonstrated in many of the diseases which have been already enumerated, but in many cases of elephantiasis, especially those met with in India, it is often quite impossible to discover a single embryo, so that it is not yet clearly proven that all cases of elephantiasis depend upon the presence of this parasite.

This short sketch of what has been worked out regarding the connexion of this nematoid worm and certain diseases has been drawn up with the view of introducing the drawings of portions of the adult male and female Filaria to the notice of the members of the Academy.

These drawings, which were kindly prepared for me by Professor A. G. Bourne, of the Madras Presidency College, from Filaria, which were found actively wriggling in lymph, on the cut surface of a scrotal elephantoid tumour, which was removed by me from a native Christian cook, on March 24th, 1888. He was a fairly nourished man of intemperate habits, aged forty-seven years, who

had resided in a part of Madras most of his life in which elephantiasis was very common amongst his poorer neighbours. He enjoyed fair health until about ten years before the operation, when he was first attacked with periodic fever, attended with swelling of the scrotum. These attacks occurred monthly for about two years, and the scrotum became enlarged to the size it was at the time of operation, or about that of a large cocoanut; it was rough, thickened, and covered with small nodules, which occasionally exuded a sticky fluid. His blood was examined under the microscope for embryos, and two were found. He made a good recovery after the operation.

As already stated, these two worms were found wriggling together in the lymph on the cut surface of the tumour. Surgeon J. Smyth, M.B., Professor of Pathology, Madras Medical College, kindly mounted them for me, but unfortunately bent the male worm in the process, on account of its great tendency to coil—a fact also noted by the late Professor Lewis in the portion he found.

The following is Professor Bourne's description of the specimen which he kindly furnished me:—

Specimen I.

This is the cephalic extremity of a female, Pl. xiv. (fig. 1). The body is capillary, smooth, nearly uniform in thickness. The mouth is simple and circular, and the head is devoid of papillæ. In many members of the genus of Filaria the head presents six oral papillæ. The vaginal aperture (fig. 1, g. p.) is placed immediately behind the pharynx; the whole vagina in this specimen is everted or simply protruded: it is difficult to say which. Dr. Smyth informs me that this protrusion took place during mounting. In Cobbold's figure the vagina is not protruded, and I think that, very probably, the protrusion may take place during life. There is a curious structure projecting (fig. 1, x.) from the side of the body; it is impossible to make out the exact relations of this structure, or to determine definitely its nature; I am inclined to think it is due to some injury.

Specimen II.

This is of great interest, as it belongs to a male, and exhibits the caudal extremity, which has never been described (figs. 2, 3, 4). The specimen measures about one and a-quarter inches in length. It is thinner than the female worm, and exhibited, while living, a great tendency to coil. Testicular structures are

visible in various places; it is difficult to be sure of the exact position of the anus; it appears to be sub-terminal. Immediately in front of the anus are a pair of spicula; these are shown in fig. 2, s., in their normal position; as a matter of fact only one remains *in situ* in the specimen; the other has been displaced in the mounting. The single spicule remaining *in situ* is shown in fig. 3. The proximal extremity is broad, while the distal extremity is capillary, but, while *in situ*, the spicula is bent upon itself, as shown in the figure. That this is the actual arrangement is shown by the appearance of the spicule which has been displaced (fig. 4), as it has become straightened out. Whether the spicules ever become straightened out during life it is impossible to say, probably not, but the arrangement is peculiar, and, as far as I am able to tell from the literature at command, unlike that obtaining in the spicula of any other nematoid.

It is, however, dangerous to formulate specific characters upon the examination of a single specimen, especially when that has been somewhat injured. The microscopical specimens and these drawings were exhibited before a meeting of the South Indian Branch of the British Medical Association in Madras, in June, 1888, and before the Pathological Section of the British Medical Association at Glasgow, in August, 1888.

DESCRIPTION OF PLATE XIV.

FILARIA SANGUINIS HOMINIS. DRAWN BY PROFESSOR A. G. BOURNE.

Fig. 1.—Anterior portion of female:—

m. mouth; *ph.* pharynx; *g. p.* genital aperture; *x.* enigmatic body; *a.* broken extremity.

Fig. 2.—Posterior portion of male:—

a. Broken extremity; *f.* testicular products showing through the cuticle; *b.* caudal extremity (? anus); *s.* spicula.

Fig. 3.—Caudal region of same specimen—one of the spicula is drawn *in situ*:—

a. The free extremity.

Fig. 4.—The other spiculum from the same specimen which became dislodged during manipulation:—

a. The portion which becomes the free extremity when the spicule is *in situ.*

XXII.

ON AN IRISH CROZIER, WITH EARLY METAL CROOK, PROBABLY THE MISSING "CROZIER OF ST. CIARAN," OF CLONMACNOISE. BY W. FRAZER, F.R.C.S.I.; Member of Council, Royal Irish Academy; and of the Royal Historical and Archæological Association of Ireland.

[Read MAY 13, 1889.]

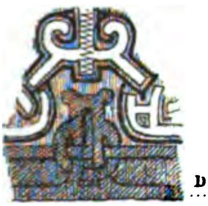
DURING a brief visit to London in the summer of last year I was offered for purchase the curved handle and decorated upper portion of the staff of an Irish baculus, or crozier, attached to a piece of wood of short size, measuring altogether twelve inches in length; the wood itself appears to be a piece of yew. It is needless to say it passed into my possession.

I was desirous, if possible, to ascertain some facts about its previous history, and, above all, how it came into the hands of the people who sold it to me; they asserted it had been in their keeping for many years, and was brought by their family originally from Ireland, but its immediate owners were either ignorant how it was obtained, nor would they give the slightest information even as to the district whence they came. They were of Irish race and name, and said they had been long settled in England. All my efforts failing to obtain further information, I had to content myself with bringing back to this country an example, hitherto unknown, of high-class Irish art—true "Opus Hibernicum," consisting of a basis of bronze, inlaid with flat strips of silver, bright-red copper, and darker-coloured niello, dispersed in flowing and characteristic patterns and interlacings, and having on the knop, or broad ring, jewel-holes, from which the gems or enamels that once filled them had long since disappeared. These jewel-holes and other prominent parts of the baculus were ornamented with gold, of which distinct traces are still perceptible.

This crozier is composed of two portions, altogether distinct from each other, of about equal lengths, the head-piece, or crook, which is much older, and has no trace of decoration by inlaying, merely consisting of a pale bronze sheath or cover, the handle once affixed

to a primitive wooden pastoral staff. Joined to this is a highly ornamented vertical piece, and separate knop, or circular flat ring. These differ from the crook in their metal work, and their fabrication displays high-class artistic skill and elaborate interlacings. It is for these portions alone we can claim a distinctive Irish origin.

I am indebted to T. H. Longfield, Esq., F.S.A., for the accompanying accurate full-sized drawings of this crozier: the smaller figure represents



its front at D, which completes the details of the ornamentation. The white pattern is composed of inlaid ribbons of silver; the dark lines are in niello; and, where the inlaying has been either lost or removed, is shown by wavy lines.

It is difficult, without further information, to determine more than approximately the age to which the crook should be assigned; it may be two hundred, possibly three hundred, years older than the inlaid portions of the staff, which, from the peculiar style of its decoration, can be referred, with much certainty, to the earlier part of the twelfth century, for it displays a close resemblance, in every respect, to one of the most beautiful of the croziers of Ireland contained

in the Academy's Museum—the great pastoral or processional staff of the Abbots of Clonmacnoise.

When we institute a close comparison between the decorations of inlaid silver, in narrow strips, and of niello, displayed on both these croziers, we find that alike in material, in their peculiar designs of flowing and interlacing curves, and in the mode of manipulation practised, both are referable to the best age of Irish art; and there is such intimate relationship in their fabrications, that we can readily fancy the same workshop produced them—nay, it appears quite probable they owe their fabrication to the same skilful workman's fingers, the patterns being designed by one artist—an opinion confirmed by their showing certain material coincidences otherwise difficult of explanation.

One of these points of similarity, though of minor importance, is that Irish croziers often have an elevated narrow ridge prolonged along the vertical portion of the crook. In that of Clonmacnoise this ridge consists of a series of figures, which at first sight might be compared to a number of hounds chasing each other; yet it may be, as suggested to me, a representation of interlaced and twining stems of some tree. In my example the ridge once present has been lost or destroyed, but the fissure remains to which it was attached. Now in the Clonmacnoise crozier (a feature of much importance, as showing mutual resemblance and relationship) this ridge springs from the upper part of a projecting support, which appears intended to represent the head of a ram, at least such is the best conjecture I am able to offer; and *an identically similar figure* occupies a similar position in my crozier; from it the fissure extends upwards alike along the middle of both the new decorated staff and the older crozier-head, but whether the ridge formerly reached so far as the latter is problematical—probably it did not—it may have terminated about the bend of the handle. This ram's head, if it be such, springs from a decorated flat ring, which terminates, and bounds the vertical part of the staff inferiorly; and in front of it, opposite the head, is another much smaller and less prominent ornamentation. Both this and the ring itself, as well as the head, were once gilt, and, in several respects, resemble the corresponding parts of the Clonmacnoise crozier. It was observing these coincidences that induced me to institute inquiries as to a possible connexion between the monastery of Clonmacnoise and my new discovery, and with other circumstances, yet to be mentioned, led to deductions appearing to have a certain support from early Irish annals, which I shall proceed to mention.

A summary of the views entertained by me would appear more appropriate if placed at the termination of my remarks, after stating fully the reasons which induce me to form my opinions; still to enable me to present, with greater distinctness, the drift of these observations to this Academy, I venture to say I regard this comparatively undecorated bronze crook as an object of exceptional antiquity amongst our Irish croziers; it appears to be the primitive termination for a wooden baculus, or walking-stick (such as all the earlier croziers were), and, therefore, of peculiar interest to students of early Irish Church history. Possibly it was a gift from foreign lands to some celebrated Irish Culdee bishop, or wandering missionary, perhaps brought back by him on his return from pilgrimage abroad after seeking for instruction and episcopal ordination—no uncommon practice for Irish clerics in the primitive times, for the possession of such a staff would in itself afford an indubitable testimony of his ecclesiastical position. After the death of its first possessor it would, in the usual course of events, pass into the stage of a cherished relic, and be preserved with veneration in the church to which he belonged, and around it legends would collect concerning the great and venerable saint; perhaps in the course of years his humbler name was forgotten, and the staff ascribed to some greater, more learned, and better-remembered cleric. In this instance it would appear as if such was the course of events: the crook of the old bishop became in time the relic of the patron saint; and when a great staff was subsequently being made for the monastery, both were decorated in the same manner; and further, certain distinctive features of the ancient ornamentation were reproduced on the later work. It must have been a highly-prized relic to be thus ornamented with the highest style of art the age was capable of producing.

I have ventured, in these statements, to claim that this old crozier was regarded as an object of special veneration, and formed one of the principal treasures of Clonmacnoise. Can I bring forward any proof from history that a relic of the description I assume this to be ever existed in that monastery? I believe I can. If we consult Lord Dunraven's classic work on Early Irish Architecture (vol. ii., p. 99), we find the following statement:—"Beautiful specimens of the jewellers' and goldsmiths' art have from time to time been found in Clonmacnoise, and are preserved in the Museum of the Royal Irish Academy and in the Petrie collection, now deposited there, all showing the same high skill, and true feeling for art, that characterized the sculpture and architecture of this district from the latter

part of the ninth to the twelfth century, but many have, we fear, been lost." Dr. Petrie, writing in the year 1821, says:—"Some thirty years ago the tomb of St. Ciaran was searched in the expectation of finding treasure, when a rosary of brass wire was discovered, a hollow ball of the same material, which opened, a chalice and wine vessel for the altar, and the 'Crozier of St. Ciaran,' were also found. Those curious relics fell into ignorant hands, and were probably deemed unworthy of preservation, but there is reason to believe that the last-mentioned relic, the 'Crozier of St. Ciaran,' still exists." Then follows a few words that are evidently erroneous:—"It was exhibited to the Society of Antiquaries about the year 1760," with a reference to Gough's *Camden*, which I have searched to no purpose; but if a crozier was discovered thirty years before the alleged date of 1821, it is obvious that it never could have been shown in 1760.

This discovery of a crozier and other relics, enumerated by Petrie, within the precincts of Clonmacnoise, appears a reliable fact, for he was careful in his assertions, and, no doubt, had sufficient information to warrant his statement. That they were discovered concealed in an old tomb, and even in that ascribed to St. Ciaran, may be equally true, but the enumeration of the objects thus found bears intrinsic evidence of the concealment of relics and altar furniture, a genuine "Cache" at some time of trouble; and beyond any question, such a miscellaneous gathering was never buried with the saint's body at the time of his interment. Now I am disposed, after careful investigation, to believe this is the missing crozier—nay, more, that its older portion was accepted and revered as a genuine relic of St. Ciaran at the time that the great processional crozier was being made; and as I have already ventured to state, I consider it was at that time specially decorated by the addition of its ornamental and jewelled staff by the workmen employed in making the latter.

I have already pointed out how these croziers resemble each other in their decoration, and especially in the rams' heads, rings of metal, and attached little ornaments found alike on both. I will now proceed to demonstrate how certain conspicuous features in the early relic were utilized and imitated in the production of the handle or crook portion of the Clonmacnoise staff itself.

In support of my views, I would direct attention to the projecting representation, in metal, of a bishop's head, on the anterior portion of my baculus, where it forms a prominent and rather exceptional decoration. The head is covered with a mitre of early shape, and on the plane surface of the staff, underneath the head, are deeply-incised lines,

delineating the chest and body of the bishop in full canonicals, having one hand raised in the attitude of benediction, with outstretched thumb and two fore-fingers, and bearing on his left side a short cross. This figure is about three-quarter length, ending abruptly. The accompanying sketches of the crozier top and its ornamentation I owe to Thomas Drew, Esq., R.H.A.

If we now proceed to examine the crook made for the crozier of Clonmacnoise, whilst it belongs to a much more advanced state of art workmanship, and is of considerably later date, we still find

employed, as a leading decoration, a head projecting from the front of the staff. But it is not the head of a bishop; it is intended either to represent a monk, or is a bearded image of the Saviour. Underneath this the artist has placed a small and perfect figure, in relief, of a cleric, which we at once recognize bears certain resemblance to the earlier and ruder representation. It is the full-length figure of a mitred Abbot; in this also the hand is raised in benediction, and there is displayed a crozier, not a cross, with inturned crook, significant

of his rank in the Church. The artist was sufficiently educated to perceive that a projecting head was not suitably placed over a flat incised representation of the body, so he got over the difficulty by still employing a similar head, simply for ornament, distinct, and altogether detached from the ecclesiastical figure; and underneath this, on the front of the crozier, and appropriated to the purpose for which it was intended, is a well-designed representation of a mitred Abbot, in full costume, and executed in good relief; thus, in all respects, maintaining the principal features of the older bishop's crook, and adopting its peculiar design, with such artistic modifications as were requisite for the newer pastoral staff.

The sides and under surface of the older crook are enriched with chased patterns, which are best understood by reference to the illustrations. I cannot find any sufficient analogy between these patterns and work of admitted Irish origin to connect them in a satisfactory manner; they are dissimilar to all such designs so far as my observations reach, and I am disposed to believe that they were originally produced on the Continent. This is, of course, mere conjecture, and the solution of this problem would require more definite information about early European croziers, especially those of Southern Gaul and Lombardy, than I am in possession of. All the results which I have arrived at would induce me to look to these central European districts as the source whence it was obtained. The importation of croziers for the use of Irish bishops in later times was not uncommon, and we possess some in the Museum of the Academy that are decorated with Limoges enamelling.

Clonmacnoise, on the banks of the Shannon, obtained a widespread reputation alike as a great centre of education and of religious training. According to the "Chronicon Scotorum," it was originally founded by St. Ciaran, "the Great, the Carpenter's Son," who died A.D. 544, at the early age of thirty-three years, soon after he had commenced its erection, in which he was assisted by King

Diarmaid Mac Corbhaill, who is recorded as having, with his own hands, aided in building the little church of stone and rude cell which was situated close to it. The date ascribed to St. Ciaran appears too early for this crozier, although in later times it bore his name. The reputation which Clonmacnoise attached to itself was of gradual growth until the latter part of the eighth century, when the fame of one of its principal teachers, Colcu, was such that it reached even to the court of Carloman, where Alcuin at that time was residing with the king. The letter written by Alcuin to Colcu is historic; with it he sent presents of oil and money, and also special gifts for the anchorites connected with the church. Colcu died A.D. 789, probably not far from the time when this crozier was brought to Ireland.

At all events we find the crozier of St. Ciaran enumerated as one of the treasured relics that Clonmacnoise possessed in the year A.D. 930. Passing into the custody of St. Ciaran's successors, it would naturally, in the course of time, become associated with the name of the founder, and, as such, come to be considered an undoubted relic of the saint. When the succession of Culdee bishops and anchorites disappeared, and been replaced by monks, and an abbot bore rule in the great buildings of that monastery which had risen instead of the primitive church and rude cell, a new crozier was required for processional purposes, and was accordingly made in the highest style of Irish art. This crozier, as I have endeavoured to point out, borrowed certain prominent and unusual features from the older pattern with such modifications as the better education in art of the age demanded, and the technical skill of the artist enabled him to introduce. At the same time the possessors of the ancient relic resolved to decorate it in a similar manner to demonstrate the esteem and veneration in which it was held by its custodians. Such an amount of toil and expense would never have been expended save on some object held in unusual reverence.

I have thus endeavoured to trace the successive steps which have led me, in my investigations, to recognize in these croziers mutual evidences of a similar origin by comparing the details of their Irish decorative twelfth-century work, and also the remarkable resemblances between the older and later croziers in their ornamentation. These results were unforeseen and unexpected, and it was only after they had forced themselves upon me that I took up the historic portion of my inquiry. Mere chance reading of Lord Dunraven's work gave me a clue, which I endeavoured to follow out.

The altars of Clonmacnoise were plundered of a number of relics, enumerated by annalists, in A.D. 1129. Of these we have no further mention; but this crozier appears to have escaped. Perhaps its custodians concealed it at this time; at all events, it was concealed during some period of sudden disturbance and trouble, and we have no record whatever, after the date A.D. 1129, of its restoration to the church to which it belonged. Re-discovered under an ancient tombstone, a fitting place for concealment, about the end of last century, by rude and ignorant persons, as Petrie says, "who unaware of, or not appreciating, its importance, either as a work of art or early relic," kept it concealed until, by fortunate chance, it was placed in my possession, and returned to its original birthplace—Ireland.

Such are the opinions I have been induced to form after a careful study of this relic, and a comparison of it with the great crozier of Clonmacnoise—one of the chief ornaments of the Museum of the Royal Irish Academy. If regarded only as an example of early Irish art work, at its best period, I have become the possessor of an exceptionally valuable object; if it be, as I am led to believe, the long-missing and highly-venerated crozier of Ciaran, of Clonmacnoise, it will take high rank amongst the antiquities we prize as illustrative of the early ecclesiastical history of Ireland.

NOTE ADDED IN THE PRESS.

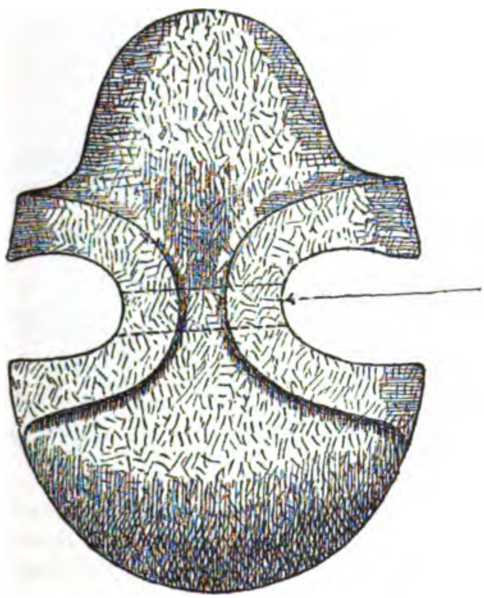
A few days since Mr. E. Johnston, of Grafton-street, who saw the crozier in London, at the Olympia Exhibition, with the person from whom I purchased it, informed me he stated it was found many years ago at Clonmacnoise, thus confirming my investigation.

XXIII.

ON A POLISHED STONE IMPLEMENT OF NOVEL FORM, AND ITS PROBABLE USE. By W. FRAZER, F.R.C.S.I.

[Read May 27, 1889.]

The implement now exhibited, made of fine polished diorite, is of unique shape, so far as my observations extend, no similar specimen having fallen under my notice in any archæological museum. It was obtained by me in June, 1888. Its possessor stated it was discovered a few months before, together with a small bronze axe with ornamented blade, and a fragment of the bronze shank of a pin, upon the

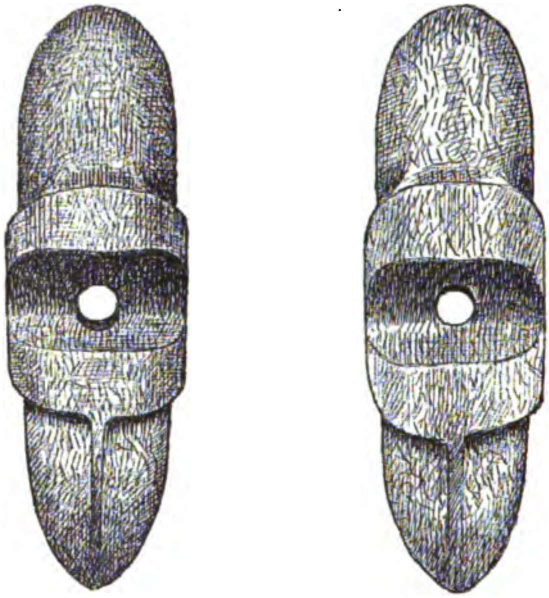


removal of a large block of stone near the ruins of Coolmore Castle, between Rathvilly and Hackettstown, on the borders of Co. Carlow.

In shape it is a flattened ovoid, 4½ inches long, and about 1⅛ inch thick, tapering at either end rather abruptly to blunt rounded edges, unsuited for cutting, and divided about its centre into broader and narrower segments, separated by oval hollows that indent the sides,

each reaching nearly to the depth of an inch, and being three-quarters of an inch wide, so that its outline somewhat resembles that of the body of a violin. These lateral depressions are margined by elevated bands on the flattened sides, that measure close to one-half inch across, and increase the thickness of the stone at these points to nearly $1\frac{1}{2}$ inch. It is perforated from side to side by a narrow cylindrical aperture, drilled with remarkable accuracy, too small to hold a wooden handle, though well adapted for attaching the stone to a thong of hide or of cord.

It is a model of skilful manipulation, and in beauty of outline not



surpassed, if equalled, by any of our polished stone antiquities. The labour demanded to produce such symmetrical smooth surfaces, on hard basaltic stone, must have been great, and its execution would occupy much time. If we consider it an implement of warfare, intended to be thrown by the hand, its accurate balance, and the proportions of its parts, would render it a formidable missile, and it would be difficult to imagine any form of weapon better calculated to do mischief in a combat, if hurled by a well-trained hand.

The character of the rock itself selected for its manufacture is noteworthy. Its basis is a dark dolerite, studded with minute stars

and wavy lines, which produce a uniform mottled surface, in which the black interspersed augitic crystals appear in groups in a dull white matrix. I submitted it to Mr. Heyland, of the Irish Geological Survey, who has special acquaintance with the minute microscopic structure of rocks, and he considers it an augitic dolerite, closely resembling the N. W. basalt of Co. Antrim, found at Scaut Hill, S. S. E. of Glenarm, his opinion being that the original rock whence it was made is Irish and Ultonian; and further, he is not at present aware of any Continental rock of similar appearance. This connexion of its rock source with Ulster is of interest in relation to some of the legends I must allude to in endeavouring to explain its probable use.

I have stated we have no specimens identical with this in shape in our museums. We do possess a limited number of highly polished stone implements, and certain forms are described by Sir William Wilde in our Museum Catalogue, which he names "Stone Battle-axes." At first I was disposed to think this implement was related to the latter, but close investigation pointed out marked differences in their construction, and I found it necessary to seek for some satisfactory solution of the difficulty by referring to the early annals of this country. Of course all these implements, made of polished hard stone, are to be considered as belonging to about the same period, and are of comparatively late date. It will therefore be well to refer to what is already ascertained about the better known objects in a brief manner.

One of these axes is figured on p. 80, fig. 66, of our Museum Catalogue. Sir W. Wilde considered it to be "one of the most beautiful specimens, both in design and execution, which has been found in the British Isles. It is composed of fine-grained hornblendic syenite." Besides this we have three or four other specimens, and in addition one partly broken in the Petrie collection, and another in the Museum of the Science and Art Department, Kildare-street. Our honorary member, Mr. Joseph Anderson, has informed me of certain examples contained in the Museum of the Antiquaries of Scotland, some of which are described and figured in his "Rynd Lectures on Scotland in Pagan Times" (*Bronze and Stone Age*).

All these implements are more or less ornamented with incised lines and raised bands, usually disposed along the borders of the broad oval surfaces, more seldom worked also on the sides, and they are always perforated by a large circular aperture, sufficiently wide to receive a serviceable wooden handle, an important difference when contrasted with the small perforation in the specimen I exhibit. We can perceive that these wide openings were usually formed by drilling

from both surfaces, as the point of junction does not always correspond, and there is often left a ridge perceptible about midway, the borings diminishing in width towards the point of meeting.

I leave altogether out of discussion those numerous examples of polished stone implements, resembling hammers and double-headed axes, with expanded terminations, so abundant on the Continent, and of which a few examples are contained in our British collections, for the only polished weapons of stone bearing relation with mine are the "battle-axes" of Sir W. Wilde. It must be borne in mind that all forms of polished stone, with artistic-shaped outlines and patterns on them, are of comparatively late age. They are found associated with urn burials, and the use of bronze implements (such as the celt found with this stone), and probably continued to be made until such time as iron weapons were coming into general use. In Mr. Anderson's list of his specimens one was found made of polished greenstone in a stone circle at Critchie, along with a series of interments of Bronze Age; another, with a cremated interment, enclosed in an urn.

When it became obvious that this new form of stone weapon could not be considered a battle-axe, I wished to ascertain whether any description contained in our early Irish records would throw light on its probable use. To those unacquainted with the Irish language, the Lectures of O'Curry on the "Manners and Customs of the ancient Irish" are invaluable for such an investigation. He has treated at considerable length on these different kinds of weapons, and brought together from early manuscripts such descriptions as enable us to form tolerably correct opinions of their various forms. I believe if we refer to these poems that the accounts before us of a stone implement called the champion handstone, Leacan Laoich Milidh and Lia Lamha Laich, will closely tally with this object.

He says that all the evidence within his reach demonstrates "that it was not an ordinary chance stone which a man can pick up anywhere, but a stone of a particular shape, and to be used, not for chance or random shots, but for a precise aim, and for some important object" (p. 278, vol. ii.). Its poetic description is that it is "a flat stone, a stone that will kill, a narrow stone, a thick thin stone, a choice weapon for success, a stone that will cut over well-secured shields, a stone that will spring over waves without stooping or curving." It is "a valuable stone, a precious stone, an accurate stone." Again, in the "Dinseanchas" we have the champion handstone of the hero Finn MacCumhail, and its history, related in

connexion with the origin of the name, Ath Liag Find, or the Ford of Finn's flat stone, now the Ford of Ballyleague at Lanesborough, on the Shannon, above Athlone.

Sideng, the daughter of Mongan of the Fairy Hills, came with a "flat stone" and chain of gold to Find, who gave them to his son Oisin. Find having used up all his weapons in the battle, snatched the stone from Oisin, and killed three sons of Eochaidh Abrad-Ruaidh, and several others of his opponents. The stone fell into the ford, where it is to remain until some Sunday morning before the day of judgment, when a nymph is to thrust her foot through its golden link and bring it to land.

As O'Curry remarks, this legend is valuable, as it shows this stone in use within historic times, and that it was considered a worthy present for a champion, and was perforated and suspended by a chain and hook of gold. The context clearly shows that it was attached to something that enabled Fian to recover it after each cast, and slay with it many successive opponents.

There are other poetical descriptions in which the champion stone is described as leaping like a snaky eel—"Coiling round the body of the Druid Colptha in a battle fought about A.D. 270, and detaining him until his victor Ceanmhor cut off his head. Allowing for poetic licence, such would be the sudden coiling of a thong attached to a stone thrown with force, and reminds us somewhat of the mode in which an American lasso is still used.

O'Curry, as in duty bound, tries to identify this hand-stone, and he considers it was one of our commonest implements, the stone celt; but these are far too numerous to answer the descriptions given of a "champion stone", which was from its value restricted to a few noble warriors of high rank, and used by them only on special occasions: besides, a perforated celt is still unknown, and would be a rarity indeed. May I add, it is quite unfitted for use as a hand weapon, a projectile, for which it would be even less suitable than any rounded paving-stone. I am assured had O'Curry ever seen such an implement as I exhibit he would have at once recognized and named it.

It still remains to mention the approximate dates of the conflicts where a champion stone was employed. The earliest appearance of such a weapon in Irish poetry is in a description of the adventures of Congal Clairingnech about B.C. 161, who kills an enchantress by throwing it at her and striking her on the head The story is related at length in vol. ii., p. 276, of O'Curry's work.

About forty years later, in the reign of Eochaidh Feidhlech, who

died B.C. 123, according to the chronology of the Four Masters, we have a poem of the rebellion of his three sons, who fought with their father at Ath Comair, near Drumcree, county Westmeath, bringing with them a band of followers collected in Ulster having champion stones. One of his sons, Lothar, hurled his weapon with a straight unavoidable blow at his father, whom it struck on the chest; he fell down, throwing up black frothy blood, but was not killed.

O'Curry remarks, with much sagacity, that as the army of the rebellious sons was probably composed of Ultonians, who are distinctly stated to have carried with them these champion stones, it is not too much to suppose they either belonged to some particular tribe, or else were natives of some particular district in which the use and manufacture of these stone weapons was specially practised.

Again, at a later epoch, A.D. 270, at the siege of Dromdamhghaire, in Munster, now Knocklow, in the S.E. of county Limerick, it is again employed, and we have a Druidic legend of its mighty powers as a weapon. The story I have already alluded to about its use by Fiad Mac Cumhaill is contained in this legend.

Last of all, about A.D. 400, in the reign of Niall of the Nine Hostages, we have an Irish prince, Eochaidh, killing a poet in his anger who stood reviling him upon the opposite bank of the river Slaney. "He suddenly drew from his girdle a *leic curad*," a champion flat stone, which he threw and struck the poet on his head, killing him on the spot. After a duration of near 600 years, the champion stone vanishes from Irish history, the latest instance of its use recorded by O'Curry being A.D. 400. Since that time 1400 years have passed, and this is, I believe, its first re-appearance in public.

When I obtained it I knew nothing of its value or historical interest. I took it for a mere variety of the polished stone battle-axe, and it was only after repeated careful study of O'Curry's records I arrived at the conclusion that it bore no relation with the latter class of weapons beyond both being formed from stone, ornamented with regular designs and highly polished; probably also they belong to the same stage of civilization: in fine, I consider it to be the long-missing champion hand-stone of Irish legend and early history.

In the Museum of the Academy, together with other interesting remains, found by Mr. Conwell in cairns of the Lough Crew hills, about twenty years since, is a round polished ball of basaltic stone, similar in material to that now described; it is about the size of a small orange. Mr. Conwell, from other circumstances, ascribed these cairns to the Ultonian kings.

XXIV.

REPORTS ON THE MAGNETIC OBSERVATIONS AT VALENTIA. By PROFESSOR FITZGERALD, M.A., F.R.S., F.T.C.D., and Mr. J. E. CULLUM, Meteorological Observer at Valentia. (Plate XV.)

[Read April 8, 1889.]

About two years ago I applied for a grant towards the expense of establishing a magnetic observatory in Valentia to compare the changes in the magnetic elements there with those at other places. Valentia was chosen for two reasons: firstly, because it was at a considerable distance from other magnetic observatories; and secondly, because the meteorological observer there, Mr. Cullum, had been trained at Kew in making magnetic observations, and was willing and most anxious to undertake them at Valentia. During the summer and autumn of 1887 Mr. Cullum erected a hut suitable for magnetic observations in the grounds of the meteorological observatory, and Trinity College lent some of their valuable magnetic instruments to equip it. In the accompanying Report Mr. Cullum has described the hut, &c., and how the observations have been conducted. Those of this last year must be considered as purely tentative. For instance, the axle and bearings of the dip circle have had to be adjusted, and the needle of the declinometer has had to be hardened and re-magnetized. From this year's observations much experience has been gained, and we hope that after a few years' observations it will be possible to decide whether it would be worth while erecting permanent self-recording instruments at Valentia. If any sensible differences exist between the changes of magnetic elements at Kew and Valentia, it would be most important to record them systematically, in view of the light that they may throw upon the theory of these changes. It would be interesting to find out whether any of the changes are simultaneous at Kew and Valentia, and, if not, at what rate they are propagated. All changes are not simultaneous, for the regular diurnal variation must evidently be propagated at the rate of— revolution of the earth. Such observations may throw light on the question as to the extent to which the neighbourhood of the sea, with its tides deforming the earth, affect the magnetic elements. It would

also be interesting to study the relation between magnetic storms and earth currents at Valentia, where the presence of one end of a trans-Atlantic cable must give special facilities for observing these latter. It would be of great interest to observe whether there were periods of alternation in these corresponding to the free period of oscillation of an electric charge on the earth, sun, or moon. These observations would also help to decide to what extent the theory was justified that attributes many of the magnetic disturbances to electric currents in the upper regions of the atmosphere.

In view of the great interest attaching to this work, I hope the Academy will advance the funds required to continue them. It will be seen from the account accompanying this report that we have already spent £12 19*s*. 6*d*. more than the grant made to us. In addition to this expenditure, we think it is necessary to purchase a chronometer. We also think it would be most desirable to erect a second smaller hut, in which a permanent declinometer should be erected, for the purpose of making observations during the occurrence of magnetic storms, so as if possible to identify particular waves of disturbance with ones recorded by the Kew magnetographs: such an identification, in even a few cases, would be of great interest, and might lead to very important results. We therefore ask for an additional grant of £40 in order to enable us to continue this work.

In conclusion, I must express my appreciation of the great service Mr. Cullum is rendering to science in assisting this work, and my very sincere thanks for the very hearty way in which he has undertaken the whole of the labour connected with it, and for the care and ability with which he has conducted it.

George Francis FitzGerald.

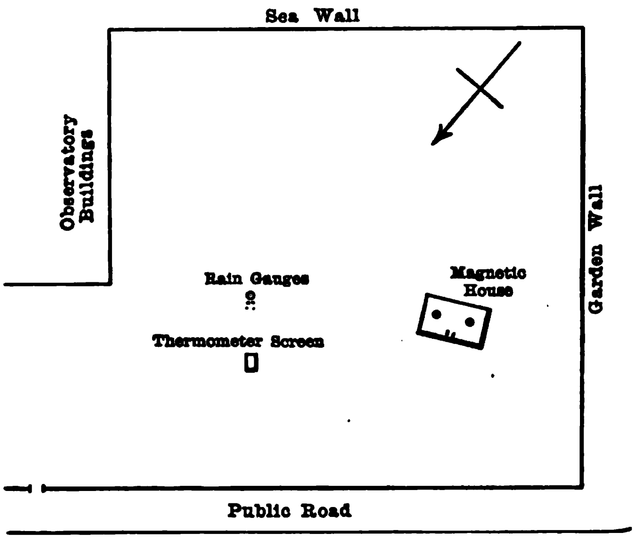
Trinity College, Dublin,
March 25, 1889.

On the Absolute Values of Terrestrial Magnetism observed at Valentia during 1888.

A small grant being obtained from the Royal Irish Academy for the purpose of making observations in Ireland of terrestrial magnetism, Mr. J. E. Cullum, Superintendent of Valentia Observatory, who had previously been Magnetic Assistant at Kew Observatory, offered (subject to the approval of the Meteorological Council) to make absolute measurements of declination, horizontal force, and dip at the observatory.

The Meteorological Council having very kindly granted the necessary permission, a wooden observing-house, fastened with copper nails, and felted roof, was erected in the observatory grounds within 20 yards of the sea, lat. 51° 54′ N., long. 10° 18′ W. The house is provided with two concrete pillars, firmly embedded in the earth, on which the instruments are supported.

A unifilar by Jones, and a dip circle by Barrow, with 3¾ in. needles, being available, were lent by Trinity College, together with a chronometer by Brockbank and Atkins, No. 879, hired for the purpose. The fittings of the collimator magnet having been altered to admit of it being used both for declination and force observations, it was sent to Kew to have its constants and corrections determined. It was there



hardened and re-magnetized, and on its return to Mr. Cullum he was able to commence the series of observations in March last, the results of which are appended. A reliable meridian mark being obtained on the schoolhouse about two miles to the south-east of the observatory, its orientation has been carefully determined by several series of Sun's altitudes, and the instrumental readings are referred to it to determine the magnetic variation.

The observatory is situated on the south sound forming the Island of Valentia, about 20 yds. from the shore, and 15 ft. above mean sea-

level. The soil is peat, over a stratum of clay and shale, there being no rocks in the immediate vicinity.

Care has been taken, in erecting the observing-house, that it is sufficiently removed from any iron fittings likely to affect the results obtained, and nothing but copper and brass have been used in the fastenings and fittings.

The observations have been made during the first and third weeks of each month; two complete sets of horizontal force measurements on the first day, one before and the other after noon; one determination of declination before noon, and one of dip after noon, on the second day; and the same again on the third day; making four complete sets of observations, the mean of which has been taken for the month's record.

The instrument used in determining the horizontal force is the unifilar, which is in two parts. For the vibrations a mahogany box, with a suspension tube, is attached to the deflection apparatus. A tubular magnet, 10 cms. long by 1 cm. in diameter, of hardened steel, in one end of which is fitted a lens, and at the other end, which is at the chief focus of this lens, a plain glass engraved with a scale. This scale is observed by the aid of a small telescope; and the time of the passage of its centre across the wire of the telescope is observed by counting the beats of a chronometer. The magnet is suspended by two fibres of unspun silk from the top of the glass tube, about 30 cms. in length, and made to vibrate in the horizontal plane on either side of its position of rest. The square of the number of vibrations in a given time is a measure of the intensity of the horizontal component of the magnetic force of the Earth, a centimetre of space, a gramme of mass, and a second of time, being the units employed.

The vibrating magnet is dismounted from its suspension, and with the wooden box in which it is swung is removed from the apparatus. The instrument is fitted with a horizontal circle capable of rotation round its axis, which also carries a copper frame, acting as a damper when the magnet to be deflected is set in motion, and tends to bring it to rest. This magnet is also a hollow cylinder, but of smaller dimensions than the one previously described, and is provided with a mirror placed vertical and normal to its axis. A telescope is screwed to the revolving base, and fitted with an ivory scale, the divisions of which are seen as reflected in the mirror of the magnet, and read by the telescope. A brass bar is fixed, its centre coinciding with the centre of the instrument, divided to centimetres, upon which the magnet previously vibrated is placed, first at 30 cms. on either side, and then at

40 cms., the readings being taken on the circle when the magnetic axis of the deflecting magnet is at right-angles to that of the suspended magnet, which is obtained by turning the circle in azimuth until the wire of the telescope cuts the centre division of the ivory scale. This is done first with the north end of the deflecting magnet to the east, and secondly to the west. Half the difference of the mean of the readings in the two positions is the angle of deflection required. By this process the ratio is obtained of the magnetic moment of the deflecting magnet to the Earth's horizontal magnetic force; the latter being to the former as 1 to the sine of the angle of deflection multiplied by half the cube of the distance employed.

The dip circle has a horizontal circle for setting it in the magnetic meridian, and a vertical one for measuring the angles which the needles make with the horizon when in that position. There are two needles, the means of their readings being taken as the angle of inclination. They are made of flat, tempered steel, about 3½ ins. long, pointed at the ends, having accurately-turned cylindrical axles at right angles to the plane of the needles. These axles rest on finely-polished agate knife edges. From the two elements, inclination and horizontal force, the vertical and total forces are calculated by means of the formulæ

Vertical force = hor. force × by tan. of the dip.
Total force = hor. force ÷ cos. of the dip.

Declination.—The same apparatus and magnet is used for this observation as for the horizontal force measurement; the magnet being fitted with a double suspension to admit of its being reversed, in case the line of collimation of the hollow steel magnet does not coincide with its magnetic axis. The position of this is first determined by finding the zero of the scale by repeated reversals of the magnet on its suspension, and noting the division which the wire of the telescope cuts on each side of the centre. The magnet is brought to rest, and the instrument turned in azimuth, until the wire of the telescope occupies the position so determined, and the reading taken on the horizontal circle. Another independent setting is made in this position when the magnet is reversed; but in this case, if the zero is found to be on the left of the centre division, it will now be on the same division on the right. A reading of this is taken on the circle and repeated, the means giving the readings obtained when the scale is erect and inverted. By this plan the difference between the axis of the tube and its magnetic axis is eliminated by taking the mean of the readings

in each position as the true position taken up by the magnet. The telescope is then directed to the mark on the schoolhouse already mentioned (p. 223), whose true bearing has been carefully determined, and the reading taken on the circle. As the suspension fibres are liable to be affected by the hygrometric state of the air, and by that means torsion introduced into the thread, an experiment is made by putting in a known amount of twist, by turning the head of the suspension piece, and noting its effect on the scale. The magnet is afterwards dismounted, and in its place a plummet of equal weight is suspended, which is allowed to take up its position of rest. If any torsion is shown, a suitable correction is applied to the reading previously obtained.

The values observed in the manner above described are given below for the months of March to December, 1888, together with those determined at Kew Observatory for the same time, the difference between them being shown. During the year several periods of disturbance have been registered by the self-recording instruments at Kew, notably in April, May, August, and October.

DECLINATION.

1888.	Va.	Kew.	V.-K.
March, . .	22° 35′	18° 8′	+ 4° 27′
April, . . .	22 42	18 8	+ 4 34
May, . . .	22 49	18 7	+ 4 42
June, . . .	22 51	18 8	+ 4 43
July, . . .	22 50	18 8	+ 4 42
August, . .	22 53	18 7	+ 4 46
September, .	22 55	18 5	+ 4 50
October, . .	22 51	18 4	+ 4 47
November, .	22 52	18 3	+ 4 49
December, .	22 49	18 1	+ 4 48
Means, . .	22 49	18 6	+ 4 43

HORIZONTAL FORCE. (x)

1888.	Mag. Mom.	Va.	Kew.	V. - K.
March, . .	1028·4	0·1741	0·1811	– 0·0070
April, . . .	1018·6	0·1741	0·1811	– 0·0070
May, . . .	1013·7	0·1742	0·1812	– 0·0070
June, . . .	1009·1	0·1743	0·1812	– 0·0069
July, . . .	1001·3	0·1744	0·1811	– 0·0067
August, . .	995·8	0·1742	0·1811	– 0·0069
September, .	992·1	0·1740	0·1810	– 0·0070
October, . .	985·8	0·1742	0·1811	– 0·0069
November, .	981·7	0·1742	0·1812	– 0·0070
December, .	976·5	0·1743	0·1811	– 0·0068
Means, . .	. . .	0·1742	0·1811	– 0·0069

DIP. (θ)

1888.	Mean of two Needles.	1888.	Mean of two Needles.
March, . .	68° 46′	August, . .	68° 45′
April, . . .	68 47	September, .	68 45
May, . . .	68 43	October, . .	68 48
June, . . .	68 44	November, .	68 48
July, . . .	68 43	December, .	68 41
Mean, . . . 68° 45′			

	VERTICAL FORCE. $x \tan \theta$.			TOTAL FORCE. $\frac{x}{\cos \theta}$.		
1888.	Va.	Kew.	V. - K.	Va.	Kew.	V. - K.
March,	0·4481	0·4397	+ 0·0084	0·4807	0·4755	+ 0·0052
April, .	0·4485	0·4392	+ 0·0093	0·4811	0·4751	+ 0·0060
May, .	0·4471	0·4399	+ 0·0072	0·4799	0·4758	+ 0·0041
June, .	0·4477	0·4389	+ 0·0088	0·4804	0·4749	+ 0·0055
July, .	0·4477	0·4390	+ 0·0087	0·4804	0·4749	+ 0·0055
Aug., .	0·4478	0·4393	+ 0·0085	0·4805	0·4752	+ 0·0053
Sept.,.	0·4474	0·4390	+ 0·0084	0·4800	0·4748	+ 0·0052
Oct., .	0·4491	0·4389	+ 0·0102	0·4817	0·4748	+ 0·0069
Nov., .	0·4489	0·4390	+ 0·0099	0·4816	0·4749	+ 0·0067
Dec., .	0·4468	0·4388	+ 0·0080	0·4796	0·4747	+ 0·0049
Means,	0·4479	0·4392	+ 0·0087	0·4806	0·4750	+ 0·0056

In Plate XV. will be found the plotted curves embodying these Tables. From the large amounts of variations it is evident that more observations are required before any satisfactory deductions can be made from them.

XXV.

ON THE DIRECTIONS OF THE LINES OF JOINTING OBSERVABLE IN THE ROCKS IN THE NEIGHBOURHOOD OF THE BAY OF DUBLIN, AND THEIR RELATIONS WITH ADJACENT COAST LINES. By J. P. O'REILLY, C. E., Professor of Mining and Mineralogy, Royal College of Science, Dublin.

[Read January 28, 1889.]

Part III.

Jointings of Bray Head and Neighbouring District.

At the meetings of February 23, 1880, and January 28, 1884, I submitted to the Royal Irish Academy two Papers on the Directions of the Main Lines of Jointing in the neighbourhood of the Bay of Dublin, and their Relations with the Adjacent Coast Lines, which have already appeared in the Academy's *Proceedings*.[1] My purpose was to bear out, by actual determinations, the proposition advanced in a previous memoir, that coast lines, in so far as regards their general directions, are closely related to the dominating jointings of the rock systems constituting these coast lines, or, in other words, that any given coast-line direction is made up of one or more principal directions observable in the jointing predominant at or near the coast considered. In these two Papers the directions recorded were mainly taken from the north side of the bay, and localities lying along the coast, so far as Skerries, and from the south side, so far as Killiney. The well-marked characters of Bray Head and the neighbouring mountains suggested these localities as fields of observation, and during the summers of 1886 and 1887 I was able to make a series of determinations of directions of jointing and of bedding, as well as of such other characteristics as seemed to bear upon the object of my research.

These results I have grouped, as in the two previous Papers, so as to render them more directly comparable therewith, adopting with that view the same method of arrangement, that is: a detailed description of the observed jointings and directions is first given with reference to the localities whereat observed.

[1] *Vide* these *Proceedings*, Ser. II., Vol. IV., Science, p. 116.

These results are then grouped so as to give mean east and west directions of jointing, and, in this Paper, also of bedding; and lastly, these directions are discussed as regards their relations with the adjacent coast lines or other principal lines of direction manifest in the district.

In order to show how far the observations detailed in this series accord with those given in the two Papers already published, they have been grouped comparatively in a special Table (facing p. 256) which summarizes, as it were, the whole of the three sets of the observations made. From the examination of the figures thus presented in this Table, it will be seen that but one new system of jointing has been added to those already determined—that, deducting the 73 directions of strikes of beds recorded in the present Paper, there remains a total number of observed jointings amounting to 678, which have been reduced to 20 mean directions west of true north, and 17 directions east of true north, or altogether to 37 directions.

It may be further inferred, that were all the jointings and lines of fissuring of Ireland observed and tabulated, as has been done for the districts studied in these Papers, they would be, in all probability, reducible, however numerous, to a relatively small number of mean east and west of true north directions, more or less frequent and prominent according to the localities and the varying physical and geological conditions of their structure. From such a mass of observations mean values for the different systems of directions could be arrived at of relatively great accuracy, and certainly closer than those recorded in the *Memoirs of the Geological Survey*, wherein for the most part they are given with values approximate to about 5° only, and without any data as to how they were obtained—whether with the aid of the magnetic compass, and, if so, what allowance was made for magnetic variation in the locality considered, at the time of observation.

That the various systems of jointing existing in the country are reducible to definite systems, having not only fixed directions, but also marked characteristics, is one of the consequences which I consider is deducible from the results recorded in these Papers. The scientific importance and significance to be assigned to them would be proportional to the degree of their relationship with the physical and geological structure of the country, and, consequently, to the agencies having brought about that present structure. Dislocations have been a main cause of change, and the centres or points from which the forces acted having given rise to these dislocations, are fairly of the domain of scientific inquiry. In order to ascertain with some approach to accuracy the positions of these centres, it is necessary to

determine with care, and systematically, the various directions of jointings and dislocation manifest on the surface of the country. Were this done, then, taking for granted that the greater number, at least, of the principal lines of fissuring and jointing may be ascribed to seismic action, and that they resulted from more or less violent and repeated seismic undulations, proceeding from either volcanic or seismic centres, the positions of these would lie on lines normal to the lines or systems of fissuring and jointing, that is, on the directions of the undulations, and would, to a certain extent, be further defined by the dips of the observed joints or fissures. Moreover, some idea or estimate of the intensities of the earthquakes might be considered as being furnished by the characteristics of the observed jointings or fissurings, and in this way the relative importance of the centres of action be defined. Nor is it only from the point of view of geological structure that the precise determination of the various systems of jointing of a country and their related centres of action are of importance. For the study of terrestrial magnetism such determinations would seem to be of still greater scientific interest, since, in a very remarkable study of the Phenomena of Terrestrial Magnetism, by Dr. Edmund Neumann (*Die Erscheinungen des Erdmagnetismus in ihrer Abhängigkeit vom Bau der Erde*, Stuttgard, 1887), he shows, by a map of Japan, on which he has laid down the directions of its isogonic lines of magnetism, the intimate relation apparent between the great lines of fissuring of that island and the magnetic variations which he had therein observed. Indeed, the main object of his Paper is to bring out distinctly this remarkable connexion. He says, p. 19, "The isogone of 5° W. corresponds in its general course with a line of structure. (Die Isogone von 5° W. fällt in ihrem allegemeine Verlauf mit einer tektonischen Linie zusammen.) This," he adds, "is a result of the very highest importance. We may say," he adds, "that the entire mountain chain describes at the points where occurs the 'fossa magna'—a crack or bend—the isogones corresponding to this crack or bend"—(Wir können sagen, das ganze Gebirge, beschreibe, dort wo die fossa magna liegt, eine knickung; die isogonen machen diese knickung mit.)[1] It would,

[1] In the same page he thus describes the fossa magna:—Ich glaube jetzt wie vormals behaupten zu dürfen, dass die fossa magna eine Spalte, eine Zerreissung darstellt, keinen Jungendlichen Einbruch eine Spalt sogar, die von hohem Alter ist wenn auch jünger als die longitudinale Hauptbruch des ganzein Gebirges.

"I think I may assert now as formerly that the 'fossa magna' represents a great joint or fracture—no mere recent break, but rather, indeed, a joint which is of great age, even though more recent than the longitudinal main fault of the entire mountain."

therefore, not be excessive to pretend that a magnetic survey of the country, or, indeed, of any other, should, to a certain extent, be brought into relation with the main lines of faulting, and that, consequently, a correct determination of these and their proper co-ordination should precede, and, as it were, mark out the ground for such a survey.

Assuming, as has already been advanced, that there is a direct relation between the systems of lines of dislocation of this country and the centres of seismic disturbance whence proceed the undulations or shocks which gave rise to them, it may be of interest to examine, from the data collected in the summaries accompanying this Paper, some very suggestive indications which they present.

Thus, it may be remarked, that for the district observed north and south of Dublin Bay and surrounding country the systems of west jointings—(I.) 14° 39′ W., (II.) 20° 8′ W., and (IV.) 28° 33′ W. subtend Iceland to the north, while their prolongations to the south cut the Pyrenees in those points of the chain the most frequently shaken by earthquakes in modern times, that is, the portion of the chain which lies between Foix and San Sebastian, of which the Pic du Midi would be about the centre. Assuming that the centres of seismic action having given rise to these dislocations should lie on normals to these directions, they should be found either to the east or to the west of these, and therefore in the direction of the Atlantic or of Great Britain; as, moreover, the dips of these west jointings are for the most part nearly vertical, it might be inferred that the source of action is proximate, and probably to the eastward, and in the channel, or connected with the seismic centres of Great Britain.

Taking another direction, that of N. 64° 16′ E., it may be observed that it represents distinctly the direction of the southern coast line of Ireland, to which occur parallels at different intervals to the northward. Examining these, as laid down on a map of Europe, such as that of Stanford (and noting that the direction already cited, N. 28° 33′ W., is nearly normal to it, and cuts Iceland between Rejkiavik and Hecla), it will be observed that this southern coast line of Ireland direction being produced crosses Great Britain and Denmark, and touches the southern part of Scandinavia near Christianstadt, running thus nearly parallel to the coast line of Holland and North Germany, between the Texel and the Gulf of Dantzic, while a parallel to it, running along the north coast of Antrim, intersects the south point of Norway, and runs parallel to the south coast of the Gulf of Finland, so noted for the disturbances which the magnetic needle there undergoes. Now,

assuming that these lines are parallel lines of dislocation and disturbance, the centre from which this proceeded should be looked for to the north or south of the direction in question; and as the dips are relatively high for the more marked jointings, it may be inferred that the centre was relatively proximate, and, in all probability, in the sea near the coast; but it might be that the seismic undulations proceeded from Iceland (lying on the normal to the direction in question), and from the neighbourhood of Hecla, this normal being in fact one of the joint systems observed and recorded in 1880 (N. 25° 52′ W.). This would not be, as an assumption, either improbable or excessive, since it has been shown by Professor Judd that "Antrim, the inner Hebrides, the Faroe Islands, and Iceland, were, during the tertiary period, included in the same petrographical province," and that "this province was of vast extent." (See Judd, on the Gabbros, Dolerites, and Basalts of Tertiary Age in Scotland and Ireland, *Quarterly Journal of the Geological Society*, vol. xlii., p. 53.) It is quite true, also, that arguing on the same grounds, the Carlingford district, which, according to the same author, "forms another great centre of eruption," may have been the focus of action, and the high dips of the jointings would favour this view. In either case, however, it is of great interest to point out this possible connexion between these great centres of disturbance and the systems of jointing in question, and in this way to bring out more prominently the importance of their study and careful determination. It may be interesting to mention here, that in Dr. Haughton's Paper "On the Newer Palæozoic Rocks which border the Menai Straits in Carnarvonshire" (*Journal of the Geological Society of Dublin*, vol. vi., 1853–4, p. 1), it is stated (p. 5), "The mean of 24 measurements of the strikes of the beds of limestone and sandstone through the whole of the undisturbed part of the district gives E. 27° N., or mag. E. and W., nearly." Now, E. 27° N. = N. 63° E. This direction would at Bray be about 62°, a close approximation to the mean value found for the general direction in question, N. 62° 12′ E. (the value N. 62° 12′ E. occurring markedly and frequently on the north side of the Lesser Sugarloaf). Finally, if we consider from this point of view the significance of the direction N. 20° 15′ E., the most frequent in point of occurrenae of the easterly directions observed on the coast line studied, it may be remarked that besides showing very interesting relations with the lines of direction in Ireland, its prolongation passes through Scotland near Comrie, and runs distinctly parallel to the north-west coast of Norway. As in the previous Papers referred to, the relations between the systems observed and the general lines of

structure of the country were pointed out, and as the further determinations herein recorded agree substantially with these directions, it is unnecessary to here recall these relations. It may, however, be noted that the two principal directions observed, N. 14° 39′ W. (with 52 observed occurrences), and N. 20° 5′ E. (with 52 observed occurrences also), very distinctly represent the general directions of the coast line of Ireland between Carnsore Head and Dundalk Bay—that they represent 15·3 per cent. of the whole of the observed directions of jointing, and thus fully bear out the proposition that the coast lines correspond in their general direction with the dominating systems of jointing observable in the neighbourhood of the section of coast line considered.

The strikes of the beds which crop out at Bray Head, as detailed in the accompanying Tables, show that those having an easterly direction markedly predominate, and in the proportion of 60 to 14, or more than fourfold, the dips being to the north-west, or more or less westerly.

From the Tables, it may be inferred that the predominating directions of strike are—(I.) N. 80° 15′ E.; (II.) N. 55° 51′ E.; (III.) N. 64° 31′ E.; and (IV.) N. 46° 36′ E.

Now, if these be compared with those easterly directions of jointing which present nearly similar values, as shown in the General Summary of Directions of Jointing (facing p. 256), it will be found that the relative frequencies stand as follows:—

Strikes of Beds.

(I.) 80° 15′ E.	(II.) 55° 51′ E.	(III.) 64° 31′ E.	(IV.) 46° 36′ E.	(V.) 71° 50′ E.

Directions of Jointing.

(VII.) 81° 17′ E.	(IX.) 53° 33′ E.	(VI.) 64° 16′ E.	(VII.) 46° 24′ E.	(XI.) 71° 20′ E.

It will be observed, that while the angular values of the two series approach closely, the degrees of frequency of occurrence as regards the values 64° and 46° differ so little, that taken in conjunction with other characteristics of these beds, the idea is suggested that there may be a relation existing between the beds on the one hand and the systems of jointing on the other. The continued examination of the rocks, and of their characteristics, led me, while engaged during two summers in taking the directions of jointing, to entertain this idea, and further examination of the question has brought me to the conclusion that, taking all the characteristics and conditions of the rocks of Bray Head into consideration, there are strong reasons for questioning the purely

sedimentary origin and nature which up to the present has been assigned to them by geologists.

The reasons which have tended to force this view upon me may be classed under the two broad heads, Physical characteristics, and Chemical composition. As, however, the further development of these reasons is not a necessary part of the subject of the present Paper, I propose to treat the question as fully as possible in a further Paper, in which will be embodied my Report on the results of the Chemical Analyses of the Rocks of Bray Head, for the execution of which the Academy has made me grants out of the yearly sum set apart for Scientific research.

In the following detail of directions (the numeration of which is continued from Part II. of this Paper), the bearings are given east or west of true north, and were reduced from magnetic bearings, the variation being taken from the Admiralty Chart of the Bay of Dublin, which gives for 1882 the variation as 22° 5′ W., decreasing at the rate of 8′ per annum; in 1886, it was 21° 23′ W.

[Detail of Observed Directions, etc.

DETAIL OF OBSERVED DIRECTIONS AND LOCALITIES.

Bray Head.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
521	At gate-house entrance to path round Head; Cambrian slates, ...	79° 27′ E.	N.N.W. at 46°.
522	On shore, not far from entrance; open joint or fissure, cutting rocks, ...	9 3 W.	To E.
523	At N.W. point of shore; little creek in rocks, apparently on a fault or joint, . . .	63 27 E.	
	Do. do. do. do., . .	66 27 E.	
524	At N.W. point of shore; another joint quite close to this, ...	50 27 E.	
525	On shore, near commencement of path; fissure, ...	1 27 E.	
526	Bathing-place; purple slate-rocks on S. side of, ...	45 27 E.	N.W. at 60°.
527	Bathing-place; marked jointing in rocks here,	74 3 W.	
528	Do. do. do. do., . .	79 3 W.	
529	S. of bathing-place; cave on shore here, .	25 27 E.	
530	S.E. point of bathing-place; joint at, . .	23 57 E.	
531	S.E. of bathing-place; great fault, . .	28 27 E.	
532	80 yards S.E. of this fault; joint in rocks, .	87 3 W.	
533	About 40 yards S.E. of last; great joint and fault, with sinter formation, . . .	81 33 W.	S. slight.
534	Eastern end of sustaining-wall on shore; joint here in rocks producing an arch, .	89 3 W.	
535	On path; apparent bedding of rocks a few yards to S. of 522, about 100 yards from commencement of path, ...	51 27 E.	N.W.
536	Railway-cutting near bridge; apparent strike of beds on S. side of railway, . . .	80 57 E.	
537	On path, quarry; beds of purple slate-rock in quarry, ...	37 27 E.	N. at 44°.
538	These beds crossed by a dyke, . . .	24 33 W.	Vertical.
539	Gully (1st); corresponding to a fault, seemingly; the axis of the gully running towards the Periwinkle rocks, . . .	77 27 E.	
540	Commencement of wall beyond 539; direction of beds here, ...	73 27 E.	N. at 77°.
541	200 yards S.E. of this; jointing in rocks, .	18 27 E.	
542	100 yards S.E. of quarry on path; beds of purple slate-rock, ...	80 27 E.	N. at 65°.
543	30 yards further S.E.; well-marked purple beds (cleared), ...	14 27 E.	N. at 67°.
	(The rocks in the interval between 542 and 543 very confused, showing in some places concretional formation and mammillated surfaces.)		

No.	Locality and Remarks.	Direction relative to true North.	Dip.
544	A few yards S.E. of 543; beds here, . .	59 27 E.	
545	About 200 yards on Bray side of Lord Meath's gate-house on path; first outcrop of quartzite on path; shows no trace of bedding, but seams of white quartz.	—	
	120 yards S.E. of quartzite outcrop; quartz veins in beds of greenstone and slate-rock,	69 33 W.	S.W. at 70°.
546	Immediately S.E. of gate-house; beds of purple slate-rocks, ...	66 27 E.	N.W. at 50°.
547	80 to 90 yards S.E. of gate-house; beds of purple slate-rocks, ...	56 27 E.	
548	Gulley of old wooden bridge; beds here, .	56 27 E.	
549	Gully of old wooden bridge; apparent direction of gully (about)	58 27 E.	
	Do. do. do. do., . .	51 57 E.	
550	S.E. of gully; beds highly pitched here, .	73 27 E.	N. 72°.
551	150 yards S.E. of gully, on path; beds higbly pitched here, ...	89 33 W.	N. 69°.
552	Further S.E.; set of purple and grey beds, .	69 57 E.	N. 50°.
553	200 perches S.S.E. of gate-house on path ("Brandy Hole"); great outcrop of quartzite, through which tunnel cut; beds about 100 yards on S. side of tunnel entrance, ...	55 27 E.	N.W. 60°.
554	Commencement of path round Head; fold of greenstone rock, ...	50 27 E.	
555	Quarry on path (537); rocks to S. of (beyond gulley), ...	73 33 W.	N. 52°.
556	First outcrop of quartzite on path (545); joint parallel to path, ...	43 33 W.	S.W. 60°.
557	80 yards S. of gate-house, at about 70 feet above path on hillside; face of bed here, .	63 33 W.	N.E. 65°.
558	"Brandy Hole" tunnel (553); beds immediately N. of, on path, ...	41 27 E.	N.W. 50°.
559	90 perches on N. side of tunnel; beds of coarse feldspathic grit with purple clay coating, joint cutting them, ...	15 27 E.	Vertical.
560	150 yards N. of "Brandy Hole" tunnel; massive beds with purple seams, . . .	78 3 W.	N. 57°.
561	Vicinity of do.; vertical jointing here frequent and close, ...	31 33 W.	
	Do. do. do. do., . . .	31 33 W.	
562	"Brandy Hole" quartzite; frequent jointing in, ...	38 33 W.	
	Do. do. do. do., . . .	34 33 W.	
563	The mass of the quartzite strikes, . . .	47 27 E.	N.W. 50°.
564	72 perches N. of tunnel in Head; gulley of old wooden bridge, apparent direction of, .	86 33 W.	

No.	Locality and Remarks.	Direction relative to true North.	Dip.
565	About 120 yards N. of tunnel entrance; beds here, ...	78 33 W.	Vertical.
566	About 100 yards do., do. do. .	84 33 W.	N. 60°.
567	About 80 yards do., do. do. .	64 33 W.	N. 77°.
568	Over tunnel, in quarry alongside path; well-marked beds, ...	82 27 E.	N. 60°.
569	Most southerly tunnel of Head. The beds here traversed by a series of vertical joints so marked, so close and frequent as to simulate bedding, as seen on the rock-face of the entrance of this tunnel, ...	39 33 W.	
	Do. do. do. do., . .	42 33 W.	
	Do. do. do. do., . .	29 33 W.	
	Do. do. do. do., . .	31 33 W.	
	Do. do. do. do., . .	37 33 W.	
	Do. do. do. do., . .	38 33 W.	
	Do. do. do. do., . .	26 33 W.	
	Do. do. do. do., . .	28 33 W.	
	Do. do. do. do., . .	39 33 W.	
570	End of path S. of old houses; beds here, .	81 33 W.	N. at 60°.
571	Old houses over tunnel; dyke of greenstone, showing on its S.W. side a cleaved and slaty band, ...	49 33 W.	N.E. at 80°.
	(The N.E. wall of the dyke presents a well-marked mammillated surface.)		
572	Old houses over tunnel; another dyke about 30 yards N. of last, ...	50 33 W.	N.E. at 77°.
573	E. side of tunnel; a dyke on this side, showing well-marked glacial striation, . .	50 3 W.	N.E. at 70°.
574	Near level of sea; system of joints so repeated as to appear as beds, N^m/S^m, . .	21 33 W.	Vertical or N.E. slightly.
	Combined with a system of jointing, . .	50 33 W.	
575	Half-way between path and sea; beds here,	55 57 E.	N.W. at 60°.
576	W. of tunnel on hill; beds here, ...	63 27 E.	
577	400 yards west of old houses; on hillside quartzite mass capping the hill, and showing Slikenside at outcrop, ...	6 27 E.	E at 75°.
578	400 yards do.; fault about 60 yards S. of 577, being plane of separation of quartzite from Slikenside, ...	65 27 E.	
579	170 yards S. of old houses; joint in quartzite mass, ...	1 27 E.	Vertical.
580	Do.; crossed by close jointing, ...	11 27 E.	

Greystones.

The beds more slaty and cleared than at Bray Head, and much folded.

581	30 yards S. of Flagstaff; beds here, . . .	45 27 E.	N.W. at 33°.
582	These beds cut by vertical joints lined with quartz, ...	37 27 E.	

No.	Locality and Remarks.	Direction relative to true North.	Dip.
583	Greystones, further S.; beds here, . .	46 27 E.	S. at 75°.
584	Do.; beds here much contorted and faulted, .	55 27 E.	N. at 35°
585	Small inlet and bathing-place S. of flagstaff; set of yellow grits with cleaved slate beds, markedly distinct from previous beds (anticlinal fold), ...	80 33 W.	N. 75°.
586	Do.; S. side of promontory cut by a series of dykes with cleaved or clay-slate sides, .	13 27 E.	Vertical.
587	Greystones, 30 yards S. of promontory (586); beds here well defined, much crumpled and folded, ...	71 27 E.	N. by W. 70.
588	Do., further south; jointing shown in beds, .	29 33 W.	N.E. 67.
589	Do., south end of promontory; beds here, .	70 27 E.	N.W. 75.

Kilruddery Demesne.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
590	Path in, from Delgany-road to Head; quartzite mass, nearest road, showing close jointing, ...	7 27 E.	
591	Do.; fault cutting this jointing on N.E. side, ...	24 3 W.	N.E. 56.
592	Do.; another fault cutting this jointing, .	55 27 E.	
593	Do. do. do. do., . .	58 27 E.	
594	Do. do. do. do., . .	60 57 E.	
595	On the path to the Head; face of quartzite mass, ...	26 27 E.	
596	Do.; apparent fault near path, full of white veins, ...	34 57 E.	
597	Do.; great fault in the quartzite mass, . .	70 27 E.	
598	Second boss of quartzite to N.E. of (590); close jointing, breaking up the mass into rhomboidal forms, ...	43 27 E.	
599	Most easterly quartzite boss; face of joint or fault on N.E. side, having caused disaggregation of the rocks, ...	26 27 E.	N.W. 80.
600	Do.; fault well marked at N.W. end of the boss, much contorted, ...	18 27 E.	
601	Do.; this fault cut off on the N.E. side by a joint, ...	47 3 W.	N.E. at 77.
602	Quartzite boss to N.E. of last (599); cut off on W. side by a fault, ...	40 57 E.	N.W. at 77.
603	On path near hilltop; outcrop of slate-rock on path, ...	63 57 E.	Vertical.
604	Path on seaside of quartzite mass; greenstone dyke in the quartzite, ...	72 33 W.	
605	Do.; joint between quartzite bosses, . .	83 33 W.	
606	Do.; slate-rocks cropping out on road, . .	83 33 W.	N. at 80.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
607	Quartzite masses of the Head separated from one another by a system of jointing, . .	24 33 W.	
608	Highest boss of quartzite; joint on south side of, ...	13 33 W.	
609	Do.; glacial striæ on highest point of boss nearest sea, showing finely-polished surfaces, ...	21 33 W.	
610	Do.; vertical jointing traversing the mass, .	13 3 W.	
611	On demesne road; outcrop of purple slate-rocks on road, ...	28° 27′ E.	
612	On demesne road, above "Brandy Hole" tunnel; great mass of white quartzite at point where the demesne-road turns S.W.,	58 27 E.	
613	Do.; fault bounding the quartzite alongside the road near N.E. end of rock, . .	54 27 E.	N.W.
	Do. do. do. do., . .	59 27 E.	
	Do. do. do. do., . .	52 27 E.	
614	Quartzite mass above "Brandy Hole" tunnel, on road in demesne; vertical jointing cutting the fault (613), and apparently corresponding to hollow betweeen the quartzite bosses at the Bray end of the Head, .	85 3 W.	
615	Alongside the quartzite; a band of purple slates, ...	40 7 E.	N.W. at 75°.
616	Same farther south, ...	57 27 E.	
617	About 5 yards N. of this quartzite outcrop; band of well-marked slate-rock, . .	52 57 E.	
618	Do.; cut—by jointing, showing itself in beds further to N.W., ...	59 33 W.	
619	Road in demesne; slate-rock cropping out on road, ...	80 57 E.	

Hillside, near Railway.

620	First outcrop of quartzite; beds in contact with (taken on hill), ...	78 27 E.	N. at 61° 30′.
621	Do. do. do. do., . .	77 27 E.	
622	Do.; nearer Bray, ...	77 27 E.	
623	On face of hill opposite the point (wrongly marked) "Brandy Hole" on Ordnance Survey; contortion of beds here, mammillated surfaces at certain points: higher up on hillside the beds appear in normal state.	—	
624	About 95 feet above path on hillside; beds within 10 yards of quartzite ridge, . .	63 57 E.	N.W. 56°.
625	Quite near summit of hill; beds of purple slate-rocks, ...	53 57 E.	Nearly vertical

No.	Locality and Remarks.	Direction relative to true North.	Dip.
626	The quartzite beds which appear to cut off these traversed by sets of joints, . . .	23 57 E.	S.E. at 74° 30′.
	Do. do. do. do., . . .	13 27 E.	
	Do. do. do. do., . . .	11 27 E.	
	Do. do. do. do., . . .	14 57 E.	S.E. at 65°.
	Do. do. do. do., . . .	14 57 E.	
627	Do. do. do. do., . . .	17 33 W.	
628	Do. do. do. do., . . .	14 33 W.	
	Do. do. do. do., . . .	14 27 E.	
	Do. do. do. do., . . .	11 57 E.	
629	10 yds. S.E. of quartzite outcrop; beds of slate-rocks, ...	63 27 E.	N.W. at 57°.
630	Further E.; do., ...	77 27 E.	
631	40 yards S.E. of contact: greenstone slate-rock much plicated.	—	
632	200 yards S.E., near boundary-wall; beds of purple slate-rock, ...	34 27 E.	N.W.
633	Boundary-wall on hillside, over gate-house; beds, ...	65 57 E.	N.W. at 66°.
634	Do.; face of rock here (fracture), . .	26 33 W.	
	Do. do. do. do., . . .	27 3 W.	
	Do. do. do. do., . . .	15 33 W.	
635	250 yards S.E. of 13th mile post of railway; in grove; well-marked fault, the rock surface showing mammillations, ...	11 33 W.	Nearly vertical, in places to W. at 70°.
	Do. do. do. do., . . .	24 33 W.	
636	In grove further S.; same fault, N^m/S^m, .	21 33 W.	
	Do. do. do. do., . . .	16 33 W.	
637	Jointing in quartzite to W. of fault, showing traces of bedding, N^m/S^m, ...	21 33 W.	
638	In grove; the fault cut off at S. end by a joint, ...	11 27 E	W. at 55°.
639	Jointing here, ...	15 33 W.	
640	Cut by a system of joints, close and frequent, and seemingly having determined the N.W. face of the rock mass looking towards Bray,	45 57 E.	
	Do. do. do. do., . . .	46 27 E.	
641	Higher up hill; joint cutting the quartzite, and showing well-marked face, . . .	76 27 E.	N. at 50°.
642	Well-marked joint, cutting off this quartzite mass on the E., ...	11 33 W.	E. at 59°.
643	Greenstones, about 80 yards N. of great fault (635), ...	65 27 E.	
644	Face of jointing, representing apparently the system of fissuring having given rise to the divisions between the summits of the Head,	52 33 W.	N.E. at 70°.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
645	Turn of road in demesne, between the two most eastern bosses of quartzite; frequent and close jointing in the quartzite mass, .	20 27 E.	Vertical, and also
	Do. do. do. do., . . .	15 3 E.	W. at 58°.
	Do. do. do. do., . . .	19 57 E.	
646	Quartzite mass; white quartzose seams traversing it, ...	75 3 W.	
647	Do; cut by a fault or joint, having caused derangement in rock, ...	65 27 E.	N.W. at 66°.
648	Do.; set of jointings bounding the mass on the E., ...	18 3 E.	N.W. about 60°.
649	Do; set of well-marked jointings here, .	35 27 E.	
	Do. do. do. do., . . .	36 27 E.	
	Do. do. dn. do., . . .	30 27 E.	
650	Third quartzite mass to S. of Head; limiting joint on N. side of, ...	84 33 W.	
651	Do.; cut by jointing, having given rise to hollow between quartzite bosses, . .	32 33 W.	
	Do. do. do. do., . . .	31 33 W.	
652	Most northerly quartzite mass (Survey mark △ 653); well-marked jointing here, .	36 27 E.	
653	Fourth quartzite mass to S. of last, the south side cut off by jointing, ...	74 33 W.	S. at 60°.
654	Closely jointed all through in a direction roughly perpendicular to this face, . .	9 33 W.	E. at 66°.
655	The continuation of this mass, cut by jointing,	29 33 W.	W. about 70°.
656	Do. do. do. do., . . .	33 33 W.	
657	Quartzite mass further W.; cut by jointing (seemingly the direction of Bray shore) N^m/S^m, ...	21 33 W.	
658	Do. do. do. do., . . .	27 33 W.	
659	Demesne-road, at about 100 yards from turn on summit; the S. end of quartzite shows a face bearing	66 27 E.	S.E. at 42°.
660	4 yards S. of this face; outcrop of bedded green slates, ...	43 33 W.	S.W. at 42°.
661	About 7 yards S. of (660); splintry and slaty greenstone dyke, ...	78 3 W.	N. at 80°.
662	At about 190 yards to S. on road; outcrop of purple beds (about 5 yards broad), . .	81 33 W.	N. at 72°.
663	Close to shore on E. side of hill; apparent continuation of these beds, ...	56 27 E.	N.W. at 68°.
664	Gully at old wooden bridge (548); above the path close to the boundary-wall which bounds the gully, beds of purple slate, undulated, and roughly cleaned, . . .	26 27 E.	Vertical.
665	Do.; cut by vertical open jointing, with ochreous lining, ...	54 33 W.	

No.	Locality and Remarks.	Direction relative to true North.	Dip.
666	Do.; beds on south side of gulley, at boundary-wall on path, ...	54 27 E.	N.W. at 56°.
667	About 45 yards further S.; beds here, .	63 27 E.	
668	About 200 yards further S.; thick beds of greenstone, ...	56 27 E.	N.W. at 59°.
669	About 240 yards further S.; thick beds of greenstone, ...	65 27 E.	N.W. at 60°.
670	About 350 yards N. of "Brandy Hole" tunnel; the beds here seemingly disturbed by greenstone "necks," showing ellipsoidal sections, and running off at a low angle to S., succeeded by a vein of ground where the beds appear much deranged and folded, .	58 27 E.	N.W. at 60°.
671			
672	Weathered thick beds of greenstone, showing much crumpling on weathered faces, .	58 27 E.	N.W. at 60°.
673	About 250 yards N. of "Brandy Hole" tunnel; thick beds, with purple, cleaved slaty partings, ...	73 27 E.	N. at 72°.
674	Do.; same beds further up hill, . . .	80 57 E.	
675	Slope on hillside, N. of "Brandy Hole" tunnel; quartzites, with apparent fault, .	86 33 W.	S. at 70°.
676	Quartzite mass, 450 yards N.W. of N. entrance of this tunnel; to S.W. of fault (675), marked jointing (vertical), ...	55 33 W.	
677	This mass seemingly limited by jointing, .	68 27 E.	N. at 43°.
678	Jointing close to last, ... [The quartzite here apparently bedded, and concordant with the greenstone beds.]	84 57 E.	N. at 54°.
679	Over northern entrance of tunnel; jointing seemingly that which gave rise to slope on N.W. side of tunnel, ...	55 3 W.	N.E. at 50°.
680	Do.; another set of jointings, most marked,	39 33 W.	S.W.
681	Do. do. do. do., . . .	39 33 W.	Vertical.
	Lesser Sugar Loaf.		
682	Kilruddery deer-park; mass of quartzite at base of hill, near deer-park entrance, jointing in, ...	15 33 W.	
683	Do. do. do. do., . . .	16 33 W.	
684	Mass of quartzite (682); joint on E. face of, ...	44 33 W.	Vertical.
685	Do.; cut by jointing, ...	17 27 E.	Vertical.
686	Do.; base line of E. side of mass (about) .	33 33 W.	
687	Quartzite cliff, half-way up slope of L. Sugar Loaf; general direction of face of cliff, N^m/S^m, ...	21 33 W.	
	Do. do. do. do., . . .	18 33 W.	
	Well-marked portion of face, . . .	16 33 W.	Vertical.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
688	Do.; jointing here, ...	16 3 W.	
689	Do. do. do. do., . . .	11 33 W.	Vertical.
690	Do. do. do. do., . . .	3 33 W.	
691	Do.; cut at N. end by jointing, . . .	29 57 E.	
692	Do. do. do. do., . . .	33 27 E.	
693	Do. do. do. do., . . .	7 27 E.	
694	Do.; cut by cross-jointing, frequently represented from N. to S., ...	74 27 E.	
695	Do.; also by frequent jointing at N. end, .	53 57 E.	
696	Do. do. do. do., . . .	54 27 E.	
697	Do.; jointing, ...	94 57 E.	
698	Quartzite cliff on E. slope of L. Sugar Loaf; general direction of E. side of cliff, . .	15 13 E.	
699	Do.; presumed strike of beds here, . .	61 33 W.	N.E. at 30°.
700	Between cliff and summit; fault with direction towards Delgany, ...	89 3 W.	Vertical.
701	Do. do. do. do., . . .	89 27 E.	N. at 60°.
702	Frequently-repeated jointing cutting the quartzite here, ...	65 27 E.	S.E. at 50°.
703	Summit of L. Sugar Loaf; jointing here frequently repeated, ...	86 27 E.	Vertical.
704	Do. do. do. do., . . .	81 27 E.	Vertical.
705	Do.; seeming bedding in the quartzite, .	83 27 E.	N. at 35°.
706	Do.; seeming bedding shown on a rock face,	88 33 W.	N. at 42°.
707	S. W. slope of L. Sugar Loaf; jointing cutting the quartzite frequent, . . .	11 3 W.	E. at 60°.
708	Western slope of L. Sugar Loaf; jointing on this side having seemingly determined the direction of the hill, ...	16 3 W.	
	Do. do. do. do., . . .	17 3 W.	
709	Do.; brecciated bed or lode (about 0^m 55 thick), ...	25 33 W.	S.E. at 60°.
710	Do., N. end of; jointing here, . . .	66 27 E.	S.E. slight.
711	Do.; Little depression, seemingly on a fault running towards centre of the Greater Sugar Loaf, under summit, . . .	55 27 E.	
712	Do.; marked jointing having determined the direction of side of quartzite mass on Barchuillia Commons, ...	62 27 E.	S.E. at 80°.
	Do. do. do. do., . . .	63 27 E.	S.E. at 80°.
	Do. do. do. do., . . .	65 27 E.	S.E. at 80°.
713	Quartzite mass facing Kilmacanogue; crossed by close and frequent jointing, . .	24 33 W.	Vertical.
714	Do.; marked vertical jointing here, . .	8 33 W.	
715	Do.; jointing running towards Kilmacanogue Church, presenting linings of MnO^2 in jointings, ...	71 27 E.	
716	Do.; jointing on N. end of ridge; very marked about 200 yards from plantation, .	26 33 W.	S.W. at 50°.

Greater Sugar Loaf.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
717	In Rocky Valley; first rocks at entrance of pass N.W. side, ...	7 27 E.	E. at 62°.
718	Do.; well-marked cross-jointing here, .	84 33 W.	N. at 72°.
719	Do.; jointing close to road marked and frequent, ...	21 27 E.	
	Do. do. do. do., . .	24 27 E.	
	Do. do. do. do., . .	17 27 E.	
720	Do.; at N.E. end of; Greenstone beds, from which road-metal taken, showing seams of cleaved slate-rock, ...	52 27 E.	S.E. at 45°.
	Do. do. do. do., . .	52 27 E.	S.E. at 35°.
721	Do.; jointing in quartzite on S.E. side of pass, ...	79 33 W.	
722	Do.; main jointing in quartzite on S.E. side of pass, ...	29 33 W.	Vertical.
723	Do.; jointing on S.E. side of pass having given rise to cliffs, ...	77 3 W.	
	Do. do. do. do., . .	80 3 W.	
724	Do.; jointing in another direction, . .	36 27 E.	
725	Do. do. do. do., . .	1 27 E.	
726	Do. do. do. do., . .	10 33 W.	
	Do. do. do. do., . .	11 3 W.	
727	Do.; great face on quartzite close to road much broken, and bent, general direction, .	84 27 E.	Vertical.
728	Do.; jointing in quartzite face at S.E. end of pass (close and frequent), . . .	0 57 E.	E. at 75°.

Shankill Quarries.

729	Northern quarry; strike of beds in, . .	83 27 E.	
730	Southern quarry; white quartzose ribs running through rock, ...	11 57 E.	Vertical.
731	Slope of hillside; giving rise to gorge treading towards Ballycorus works, . . .	40 13 W.	
732	In northern quarry; great fault with brecciated filling, cemented by MnO^2 and Fe^2O^3, ...	21 33 W.	
	Do.; the beds dipping here at about . .	—	28°.
733	Do.; set of jointings in beds, . . .	61 33 W.	

Carrickmines Station.

734	Granite hill to S. of; fault on joint in the granite having a milk-white quartz lining,	42 3 W.	

Hill facing Ballycorus Works.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
735	Quarry on; face of jointing in quarry, .	42 33 W.	
736	Do.; cut by vertical jointing, ...	59 27 E.	
737	Do.; extended vertical jointing on S. side of quarry, ...	40 33 W.	
738	Do.; joint further S. showing an eurite band,	39 3 W.	
739	Do; well-marked lode, with quartz and barytes gangue, on N.E. side of quarry, .	21 33 W.	
740	Do.; vertical jointing, seemingly a lode, to N.E. of last, and about 12 feet from it, .	54 3 W.	

By-road to Rathmichael Church.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
741	Near old Round Tower; mica-schist out-crop on, ...	45 27 E.	
742	In field beside the church; bed cropping out in, ...	45 57 E.	S.E. at 48.

Knock Lyon Road.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
743	Slates on road leading up to Mountpelier, .	84 3 W.	Vertical.
744	Nodular quartz bands in slate-rock, . .	45 57 E.	

Mountpelier Hill.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
745	Road to house in quarry on left-hand side; Greenstone dyke, ...	51 57 E.	Vertical.
746	In quarry; dyke with gangue of feldspar and quartz, ...	43 33 W.	
747	Do.; crossed by dykes, broken and shattered, and much weathered at surface, . . .	72 57 E.	
748	Vertical joints in greenstone to the E. of house, from which road-metal taken, .	16 33 W.	
749	S.E. of old house, in stream; outcrop of slate-rock with quartz nodules, . . .	48 27 E.	

Boher-na-Breena Road.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
750	Dyke, forming part of wall on road side, N^m/S^m, ...	21 33 W.	

Old Quarry S. of Clonskeagh Bridge.

No.	Locality and Remarks.	Direction relative to true North.	Dip.
751	Dodder River; jointing on S.W. side of, showing a well-marked face, ...	88 33 W.	

CLASSIFIED SUMMARY OF DIRECTIONS OF JOINTING WEST OF NORTH.

No.	Direction.
690	3° 33′ W.

No.	Direction.
522	9° 3′ W.
635	11 33 W.
642	11 33 W.
654 *f*	9 33 W.
	9 33 W.
689	11 35 W.
707 *f*	11 3 W.
	11 3 W.
714 *f*	8 33 W.
	8 33 W.
726	10 33 W.
726	11 3 W.
Total degrees, ...	123 36

Mean, .. $\frac{123° \ 36'}{12}$ = 10 18 W.

No.	Direction.
608	13° 33′ W.
628	14 33 W.
634	15 33 W.
636	16 33 W.
639	15 33 W.
682	15 33 W.
683	16 33 W.
687	16 33 W.
	16 33 W.
687	16 3 W.
708	16 3 W.
708	17 3 W.
748	16 33 W.
Total degrees, ...	205 39

Mean, .. $\frac{205° \ 39'}{13}$ = 15 54 W.

No.	Direction.
672	17° 33′ W.
687	18 33 W.
Total degrees, ...	36 6

Mean, .. $\frac{36° \ 6'}{2}$ = 18 3 W.

No.	Direction.
574	21° 33′ W.
636	21 33 W.
637	21 33 W.
657	21 33 W.
687	21 33 W.
732	21 33 W.
739	21 33 W.
750	21 33 W.
Mean, ...	21 33 W.

No.	Direction.
538	24° 33′ W.
591	24 3 W.
607	24 33 W.
635	24 33 W.
709	25 33 W.
713	24 33 W.
Total degrees, ...	147 48

Mean, .. $\frac{147° \ 48'}{6}$ = 24 38 W.

No.	Direction.
569	26° 33′ W.
569	28 33 W.
634	26 33 W.
634	27 3 W.
658	27 33 W.
716	26 33 W.
Total degrees, ...	162 48

Mean, .. $\frac{162° \ 48'}{6}$ = 27 8 W.

No.		Direction.		
561 *f* ..	..	31°	33′	W.
		31	33	W.
561 *f* ..	..	31	33	W.
		31	33	W.
562 *f* ..	..	34	33	W.
		34	33	W.
569 *f* ..	..	31	33	W.
		31	33	W.
569 *f* ..	..	29	33	W.
		29	33	W.
588 ..	..	29	33	W.
651 ..	..	32	33	W.
651 ..	..	31	33	W.
655 ..	..	29	33	W.
656 ..	..	33	33	W.
680 ..	..	33	33	W.
686 ..	..	33	33	W.
722 ..	..	29	33	W.
Total degrees, ..	..	570	54	

Mean, .. $\frac{570° \ 54'}{18} = 31 \ 43$ W.

No.		Direction.		
562 *f* ..	..	38°	34′	W.
		38	33	W.
569 *f* ..	..	39	33	W.
		39	33	W.
569 *f* ..	..	42	33	W.
		42	33	W.
569 *f* ..	..	37	33	W.
		37	33	W.
569 *f* ..	..	38	33	W.
		38	33	W.
569 *f* ..	..	39	33	W.
		39	33	W.
681 ..	..	39	33	W.
731 ..	..	40	13	W.
734 ..	..	42	3	W.
736 ..	..	42	33	W.
737 ..	..	40	33	W.
738 ..	..	39	3	W.
Total degrees, ..	..	716	34	

Mean, .. $\frac{716° \ 34'}{18} = 39 \ 49$ W.

No.		Direction.		
556 ..	..	43°	33′	W.
684 ..	..	44	33	W.
746 ..	..	43	33	W.
Total degrees, ..	..	131	39	

Mean, .. $\frac{131° \ 39'}{3} = 43 \ 53$ W.

No.		Direction.		
601 ..	..	47°	3′	W.
571 ..	..	49	33	W.
572 ..	..	50	33	W.
573 ..	..	50	3	W.
574 *f* ..	..	50	33	W.
		50	33	W.
644 ..	..	52	33	W.
Total degrees, ..	..	350	51	

Mean, .. $\frac{350° \ 51'}{7} = 50 \ 7$ W.

No.		Direction.		
665 ..	..	54°	33′	W.
676 ..	..	55	33	W.
679 ..	..	55	3	W.
740 ..	..	54	3	W.
Total degrees, ..	..	219	12	

Mean, .. $\frac{219° \ 12'}{4} = 54 \ 48$ W.

No.		Direction.		
557 ..	..	63°	33′	W.
618 ..	..	59	33	W.
733 ..	..	61	33	W.
Total degrees, ..	..	184	39	

Mean, .. $\frac{184° \ 39'}{3} = 61 \ 33$ W.

No.		Direction.		
715 ..	..	71°	27′	W.

No.		Direction.		
527 ..	..	74°	3′	W.
604 ..	..	72	33	W.
646 ..	..	75	3	W.
653 ..	..	74	33	W.
Total degrees, ..	..	296	12	
Mean, ..	$\frac{296° \ 12'}{4}$ =	74	3	W.

No.		Direction.		
605 ..	..	83°	33′	W.
614 ..	..	85	3	W.
650 ..	..	84	33	W.
718 ..	..	84	33	W.
Total degrees, ..	..	337	42	
Mean, ..	$\frac{337° \ 42'}{4}$ =	84	26	W.

No.		Direction.		
528 ..	..	79°	3′	W.
533 ..	..	81	33	W.
661 ..	..	78	3	W.
721 ..	..	79	33	W.
723 ..	..	77	3	W.
723 ..	..	80	3	W.
Total degrees, ..	..	475	18	
Mean, ..	$\frac{475° \ 18'}{6}$ =	79	13	W.

No.		Direction.		
532 ..	..	87°	3′	W.
534 ..	..	89	3	W.
564 ..	..	86	33	W.
675 ..	..	86	33	W.
700 ..	..	89	3	W.
751 ..	..	88	33	W.
Total degrees, ..	..	526	48	
Mean, ..	$\frac{526° \ 48'}{6}$ =	87	48	W.

DIRECTIONS OF JOINTINGS EAST OF NORTH.

No.		Direction.		
525 ..	..	1°	27′	E.
579 ..	..	1	27	E.
725 ..	..	1	27	E.
728 *f* ..	..	0	57	E.
		0	57	E.
Total degrees, ..	..	6	15	
Mean, ..	$\frac{6° \ 15'}{5}$ =	1	15	E.

No.		Direction.		
577 ..	..	6°	27′	E.
590 ..	..	7	27	E.
693 ..	..	7	27	E.
717 ..	..	7	27	E.
Total degrees, ..	..	28	48	
Mean, ..	$\frac{28° \ 48'}{4}$ =	7	7	E.

No.		Direction.		
580 *f* ..	..	11°	27′	E.
		11	27	E.
626 *f* ..	..	11	27	E.
		11	27	E.
628 *f* ..	..	11	57	E.
		11	57	E.
730 ..	..	11	57	E.
638 ..	..	11	27	E.
Total degrees, ..	..	93	6	
Mean, ..	$\frac{93° \ 6'}{8}$ =	11	38	E.

No.		Direction.
559 ..	..	15° 27′ E.
286 ..	..	13 27 E.
626 *f* ..	..	13 27 E.
		13 27 E.
626 *f* ..	..	14 57 E.
		14 57 E.
626 *f* ..	..	14 57 E.
		14 57 E.
628 *f* ..	..	14 27 E.
		14 27 E.
645 *f* ..	..	15 3 E.
		15 3 E.
698 ..	..	15 33 E.
Total degrees, ..	..	190 9

Mean, .. $\frac{190° \; 9'}{13}$ = 14 38 E.

No.		Direction.
541 *f* ..	..	18° 27′ E.
		18 27 E.
600 ..	..	18 27 E.
645 *f* ..	..	20 27 E.
		20 27 E.
645 *f* ..	..	19 57 E.
		19 57 E.
648 *f* ..	..	18 3 E.
		18 3 E.
685 ..	..	17 27 E.
719 *f* ..	..	21 27 E.
,, ..	..	21 27 E.
,, ..	..	17 27 E.
,, ..	..	17 27 E.
Total degrees, ..	..	267 30

Mean, .. $\frac{267° \; 30'}{14}$ = 19 6 E.

No.		Direction.
529 ..	..	25° 27′ E.
530 ..	..	23 57 E.
595 ..	..	26 27 E.
599 ..	..	26 27 E.
626 ..	..	23 57 E.
719 ..	..	24 27 E.
Total degrees, ..	..	150 42

Mean, .. $\frac{150° \; 42'}{6}$ = 25 7 E.

No.		Direction.
531 ..	..	28° 27′ E.
649 *f* ..	..	30 27 E.
		30 27 E.
691 ..	..	29 57 E.
Total degrees, ..	..	119 18

Mean, .. $\frac{119° \; 18'}{4}$ = 29 50 E.

No.		Direction.
582 ..	..	37° 27′ E.
296 ..	..	34 57 E.
649 *f* ..	..	35 27 E.
		35 27 E.
649 *f* ..	..	36 27 E.
		36 27 E.
652 *f* ..	..	36 27 E.
		36 27 E.
692 ..	..	33 27 E.
724 ..	..	36 27 E.
Total degrees, ..	..	359 0

Mean, .. $\frac{359° \; 0'}{10}$ = 35 54 E.

No.		Direction.
602 ..	..	40° 57′ E.

No.		Direction.
640 *f* ..	..	45° 57′ E.
		45 57 E.
640 *f* ..	..	46 27 E.
		46 27 E.
598 *f* ..	..	43 27 E.
		43 27 E.
Total degrees, ..	..	271 42

Mean, .. $\frac{271° \; 42'}{6}$ = 45 17 E.

No.	Direction.		
524	50°	27′	E.
549	51	57	E.
613	54	27	E.
613	52	27	E.
695 *f*	53	57	E.
	53	57	E.
695 *f*	54	27	E.
	54	27	E.
745	51	57	E.
Total degrees,	478	3	
Mean, $\frac{478°\ 3'}{9}$ =	53	7	E.

No.	Direction.		
549	58°	27′	E.
592	55	27	E.
593	58	27	E.
594	60	57	E.
612	58	27	E.
613	59	27	E.
711	55	27	E.
736	59	27	E.
Total degrees,	466	6	
Mean, $\frac{466°\ 6'}{8}$ =	58	16	E.

No.	Direction.		
523	63°	27′	E.
523	66	27	E.
578	65	27	E.
643	65	27	E.
647	65	27	E.
659	66	27	E.
697	64	57	E.
702 *f*	65	27	E.
	65	27	E.
710	66	27	E.
712 *f*	62	27	E.
	62	27	E.
712 *f*	63	27	E.
	63	27	E.
712 *f*	65	27	E.
	65	27	E.
Total degrees,	1037	42	E.
Mean, $\frac{1037°\ 42'}{16}$ =	64	51	E.

No.	Direction.		
597	70°	27′	E.
677	68	27	E.
Total degrees,	138	54	
Mean, $\frac{138°\ 54'}{2}$ =	69	27	E.

No.	Direction.		
641	76°	27′	E.
694 *f*	74	27	E.
	74	27	E.
747	72	57	E.
Total degrees,	298	18	
Mean, $\frac{298°\ 18'}{4}$ =	74	35	E.

No.	Direction.		
704	81°	27′	E.
727	84	27	E.
678	84	57	E.
703	86	27	E.
Total degrees,	337	18	
Mean, $\frac{337°\ 18'}{4}$ =	84	20	E.

No.	Direction.		
701	89°	27′	E.

TABLE SHOWING MEAN EASTERLY AND WESTERLY DIRECTION OF JOINTINGS.

Mean Directions of W. of N. Jointings.			Mean Directions of E. of N. Jointings.		
Order of Frequency.	Numbers Observed.	Mean Values.	Order of Frequency.	Numbers Observed.	Mean Values.
XI.	1	3° 33′ W.	VIII.	5	1° 15′ E.
IV.	12	10 18 W.	IX.	4	7 7 E.
III.	13	15 54 W.	VI.	8	11 38 E.
X.	2	18 3 W.	III.	13	14 38 E.
V.	8	21 33 W.	II.	14	19 6 E.
VII.	6	24 38 W.	VII.	6	25 7 E.
VII.	6	27 8 W.	IX.	4	29 50 E.
II.	18	31 43 W.	IV.	10	35 54 E.
I.	18	39 49 W.	XI.	1	40 57 E.
IX.	3	43 53 W.	VII.	6	45 17 E.
VI.	7	50 7 W.	V.	9	53 7 E.
VIII.	4	54 48 W.	VI.	8	58 16 E.
IX.	3	61 33 W.	I.	16	64 51 E.
XI.	1	71 27 W.	X.	2	69 27 E.
VIII.	4	74 3 W.	IX.	4	74 35 E.
VII.	6	79 13 W.	IX.	4	84 20 E.
VIII.	4	84 26 W.	XI.	1	89 27 E.
VII.	6	87 48 W.			

STRIKES OF BEDS EAST.

No.	Direction.		
521	79°	27′	E.
536	80	57	E.
542	80	27	E.
568	82	27	E.
619	80	57	E.
620	78	27	E.
621	77	27	E.
622	77	27	E.
630	77	27	E.
674	80	57	E.
705	83	27	E.
729	83	27	E.
Total degrees,	962	54	
Mean, $\frac{962^\circ\ 54'}{12}$ =	80	15	E.

No.	Direction.		
540	73°	27′	E.
550	72	27	E.
552	69	57	E.
587	71	27	E.
589	70	27	E.
673	73	27	E.
Total degrees,	431	2	
Mean, $\frac{431^\circ\ 2'}{6}$ =	71	50	E.

No.	Direction.		
546	66°	27′	E.
576	63	27	E.
603	63	57	E.
624	63	57	E.
629	63	27	E.
633	65	57	E.
667	63	27	E.
669	65	27	E.
Total degrees,	516	6	
Mean, $\frac{516^\circ\ 6'}{8}$ =	64	31	E.

No.	Direction.		
544	59°	27′	E.
616	57	27	E.
671	58	27	E.
672	58	27	E.
Total degrees,	233	48	
Mean, $\frac{233^\circ\ 48'}{4}$ =	58	27	E.

No.	Direction.		
547	56°	27′	E.
548	56	27	E.
553	55	27	E.
575	55	57	E.
584	55	27	E.
616	57	27	E.
625	53	57	E.
663	56	27	E.
666	54	27	E.
668	56	27	E.
Total degrees,	558	30	E.
Mean, $\frac{558^\circ\ 30'}{10}$ =	55	51	E.

No.	Direction.		
535	51°	27′	E.
554	50	27	E.
617	52	57	E.
720	52	27	E.
720	52	27	E.
Total degrees,	259	45	
Mean, $\frac{259^\circ\ 45'}{5}$ =	51	58	E.

No.		Direction.
526	.. ..	45° 27′ E.
563	.. ..	47 27 E.
581	.. ..	45 27 E.
741	.. ..	45 27 E.
742	.. ..	45 57 E.
744	.. ..	45 57 E.
749	.. ..	48 27 E.
Total degrees, ..	..	326 9

Mean, .. $\frac{326° \ 9'}{7} = 46 \ 36$ E.

No.		Direction.
537	.. ..	37° 27′ E.
582	.. ..	37 27 E.
632	.. ..	34 27 E.
Total degrees, ..	..	109 21

Mean, .. $\frac{109° \ 21'}{3} = 36 \ 27$ E.

No.		Direction.
558	.. ..	41° 27′ E.
615	.. ..	40 7 E.
Total degrees, ..	..	81 34

Mean, .. $\frac{81° \ 34'}{2} = 40 \ 47$ E.

No.		Direction.
611	.. ..	28° 27′ E.
664	.. ..	26 27 E.
Total degrees, ..	..	54 54

Mean, .. $\frac{54° \ 54'}{2} = 27 \ 27$ E.

No.		Direction.
543	.. ..	14° 27′ E.

STRIKES OF BEDS WEST.

No.		Direction.		
551	.. ..	89°	33′	W.
706	.. ..	88	33	W.
Total degrees, ..	..	178	6	
Mean, ..	$\frac{178° 6'}{2}$ =	89	3	W.

No.		Direction.		
555	.. ..	73°	33′	W.

No.		Direction.		
566	.. ..	84°	33′	W.
606	.. ..	83	33	W.
743	.. ..	84	3	W.
Total degrees, ..	..	252	9	
Mean, ..	$\frac{252° 9'}{3}$ =	84	3	W.

No.		Direction.		
567	... ..	64°	33′	W.
699	.. ..	61	33	W.
Total degrees, ..	..	126	6	
Mean, ..	$\frac{126° 6'}{2}$ =	63	3	W.

No.		Direction.		
560	.. ..	78°	3′	W.
565	.. ..	78	33	W.
570	.. ..	81	33	W.
585	.. ..	80	33	W.
662	.. ..	81	33	W.
Total degrees, ..	..	400	15	
Mean, ..	$\frac{400° 15'}{5}$ =	80	3	W.

No.		Direction.		
660	.. ..	43°	33′	W.

TABLE SHOWING MEAN WESTERLY AMD EASTERLY DIRECTIONS OF STRIKES OF BEDS.

Mean Strikes of Beds W. of N.			Mean Strikes of Beds E. of N.		
Order of Frequency.	Numbers Observed.	Mean Values.	Order of Frequency.	Numbers Observed.	Mean Values.
III.	2	89° 3′ W.	I.	12	80° 15′ E.
II.	3	84 3 W.	V.	6	71 50 E.
I.	5	80 3 W.	III.	8	64 31 E.
IV.	1	73 33 W.	VII.	4	58 27 E.
III.	2	63 3 W.	II.	10	55 51 E.
IV.	1	43 33 W.	VI.	5	51 58 E.
			IV.	7	46 36 E.
			IX.	2	40 47 E.
			VIII.	3	36 27 E.
			IX.	2	27 27 E.
			X.	1	14 27 E.

XXVI

ON THE *BULLÀN*, OR ROCK-BASIN, AS FOUND IN IRELAND; WITH SPECIAL REFERENCE TO TWO INSCRIBED EXAMPLES. By W. F. WAKEMAN, F.R.H.A.A.I. (With Plates XVI., XVII., and XVIII.)

[Read June 11, 1888.]

Basin-like hollows, artificially formed in the undisturbed rock, or sunk in boulders, are of frequent occurrence in almost every district in Ireland.

These very curious and, indeed, mysterious relics of an early, but as yet unascertained period, are usually styled by Gaelic-speaking people *bullâns*, which term may be translated "Little Holes."

Though remains of this class have for some time attracted the attention of not a few writers on the subject of Irish antiquities, no attempt, as far as I know, has hitherto been made to classify them, or to point to specialities which many most interestingly present. They seem to have been overlooked almost, or entirely, by Petrie, O'Donovan, O'Curry, Lord Dunraven, Du Noyer, and Sir William Wilde. Like the crannog question, theirs had long remained without inquiry until the bishop of Limerick, the Right Rev. Charles Graves, in Papers read at meetings of this Academy, set antiquaries on a new train of thought. Dr. Graves seems to have been of opinion that our rock-markings, cups, basins, &c., have been connected with sepulchral rites. His lordship, I have no doubt, has shot an arrow in the right direction.

As *bullâns* very frequently occur in apparent connexion with a considerable number of our most venerable ecclesiastical establishments, they have been supposed by some writers to be unquestionably of Christian origin, and to have served the purpose of baptismal fonts. We find them, for instance, at Glendalough, Co. Wicklow; Cong, Co. Galway; Ullard, Co. Kilkenny; Templenaffrin, Co. Fermanagh; Killinagh, in the same district; Roscom, Co. Galway; Rathmichael, Co. Dublin; Inismurray, Co. Sligo; and in scores of other sites of primitive Christianity in Ireland.

If they had been intended for fonts, it is impossible to account for

the appearance on the one rock, or boulder, of ten, seven, five, four, three, or two basins. One cavity or basin would surely have sufficed for the requirements of baptism. Sometimes one hollow touches, or opens into, another.

In the *Journal of the Royal Historical and Archæological Association of Ireland* for July, 1875, p. 438, Dr. Martin contends that *bullâns* are simply rude mortars, in which Churchmen of an early period had pounded or ground their corn for food. Mr. G. H. Kinahan would appear to have adopted a like idea. In the same publication for January and April, 1888, p. 332, Mr. J. Browne, M.R.I.A., after noticing a work of this kind, called "St. Columb's Font," which appears to have been at one time in the graveyard of the old church of Desert-Toghill, Co. Londonderry, writes:—

"The question suggests itself to me—Could these *bullân* stones have been used for the reception of exposed children? for, as far back as the time of Justinian, houses of mercy for children were founded by him. The churches and church charities became refuges for this unfortunate class."

Mr. Browne, I think, could not have personally examined even a few of the remains under question. The late Rev. James Graves has remarked that there was some probability in the view expressed by Dr. Martin that these basins had been designed for grinding or pounding operations:—

"He had no doubt that the clergy lived close to, if not within, the ancient parish churches. In many instances the arrangements for a loft or upper room might yet be traced at the west end of some of these ruined buildings. The stones were so extremely rude that there was a difficulty in believing them to have been used as fonts even at the earliest period of Christianity in Ireland, and the hollows, certainly, were too small to have served for total immersion. On the contrary, however, it must be remembered that if unsuited for baptismal purposes, many of these *bullâns* were also, from their depth and small size, ill-fitted for mortars. There was a suspiciously pagan aspect about this class of ancient remains."

Mr. Graves seems to have had in mind only those examples which occur in the vicinity of primitive ecclesiastical sites; he does not appear to have considered the marked variety in the distribution of these mysterious waifs of time. They may be observed in districts which had never possessed a church, Christian cemetery, or holy well; along the shores of low-lying lakes or rivers; upon or near the summits of lofty hills; within natural or artificial caverns. Examples

of the larger kind are to be seen in the chambered carns of Newgrange, Dowth, and Sliabh-na-Cailligh e. (See Plate XVIII., fig. 1.)

Some years ago, when exploring the rich, pagan, urn-bearing cemetery of Drumnakilly, near Omagh, Co. Tyrone, I was fortunate enough to disinter several stones, evidently the floors of cists. Each of these exhibited large cup-hollows, or *bullân*-like excavations, over which highly decorated cinerary vases containing large quantities of burnt human bones were found *in situ*, placed mouth downward. Two of these stones I have deposited in the Kilkenny Museum. (See Plate XVI., figs. 1 and 2; see also Plate XVIII., fig. 3.) Now here at least four well-marked bowls or hollows of the kind under notice were discovered certainly associated with funeral rites or usages, upon the exact nature of which, with our present knowledge, it is, perhaps, useless to speculate. This "find," however, suggests the idea that the basins already referred to, as occurring in some of our greater carn chambers, may have been formerly surmounted by sepulchral vases of which no trace remains.

Before proceeding further, it may be well that I should draw attention to the characteristics which the *bullâns* usually present. In plan they are invariably more or less circular, while in section they vary considerably. (See Plate XVIII., fig. 4.) The majority are simply bowl-shaped, with a depth about equal to their diameter; while others present the figure of an acutely-pointed cone. They rarely exceed eighteen inches in diameter, and it should be observed that many examples are considerably smaller. In not a few instances the hollow is flat-bottomed and extremely shallow—sometimes little more than a couple of inches in extreme depth.

Concerning remains of this class many stories are current amongst our country people; but such legends are scarcely worthy of serious attention, and not a few of them are obviously concoctions of comparatively recent times. In a note, however, to the late Rev. F. Shearman's *Loca Patriciana*, 4th series, vol. iii., p. 281, of the *Journal R.H.A.A.I.*, an interesting reference to a stone of the kind will be found. *Mesgegra*, King of Leinster, in the first century of the Christian era is slain, and decapitated by *Conal Cearnach*, the champion of Ulster. The head is laid upon a stone, and the tale records "that the blood pierced the stone, and flowed through it to the ground." This relic of pagan days is said still to remain in the stream opposite the ruined Franciscan church of Clane. "It is a *bullân* stone, and has an inverse conical cavity eighteen inches deep and as many wide on its upper surface."

But, as I may venture to suggest, the hollows under notice may have been associated in some way with other than mere funeral or sepulchral ceremonies. They, as already remarked, are numerously found in the immediate vicinity of many of our oldest Christian establishments. In connexion with each primitive church is generally a well of a class which there is every reason to believe was in ante-Christian times in Ireland considered sacred. With the water of many of these founts St. Patrick, and other pioneers of the Faith, baptized their converts. Hence the estimation in which certain springs are held with us to this day. It is very interesting to notice how frequently a *bullán*-stone is found close to, or within a short distance of, a well. There would seem to be a close connexion between them, and one is usually considered by our conntry people as sacred as the other. May not the *bullán*, in common with the fount, have at times suggested a site to the early church builder? and may not it, like the well, have served some end sacred in the imagination of our pagan forefathers? Be this as it may, two, at least, of our most remarkable *bulláns* would appear to bear marks of their having, like certain of the wells, been consecrated to Christian purposes. (See Plate XVII., fig. 3.) That this idea may not appear to be overstrained, I beg to exhibit a drawing and rubbing made from a hitherto unnoticed inscription which occurs upon a fine *bullán* rock, or boulder, situated in the immediate vicinity of the extremely ancient church of Kill-of-the-Grange, near Monkstown, Co. Dublin. It reads DOM, and may be considered to stand for DOMINI, or DOMINO; or, possibly, for the words DEO OPTIMO MAXIMO. Scribings of this class are thus alluded to by Dr. Petrie in a letter addressed to the late Earl of Dunraven, and partly reproduced in the valuable work on inscriptions found in Ireland, edited by Miss Stokes:—

"With reference to the antiquity of your incised Kerry crosses, I do not know what I can add to the simple expression of my opinion that I consider them unquestionably of the fifth, or at the latest sixth, century; and perhaps I should add that such cross-inscriptions, as well as the letters dns, dni, dno, or dñs, dñi, or dño, which so often accompany them—abbreviations of DOMINUS, DOMINI, DOMINO—are almost peculiar to the ancient territory of Kerry and its islands, in which such remains, like its Ogham inscriptions, are so common, and in which I cannot but believe that Christianity was first planted."

The letters engraved on the Kill-of-the-Grange *bullán* are, as will be acknowledged by experts in such matters, perhaps as old as any

lapidary inscription of Christian times found in Ireland. It is not, I believe, too much to assume that they were meant to purify the monument from its pagan associations and taint.

The Kerry stones referred to by Petrie, together with their dedicatory inscriptions, exhibit primitive incised or punched crosses, but no name of a person to be commemorated. The most important of these remains is a pillar-stone at Kilmalkedar, which, in addition to a cross and the letters DNI (DOMINI), exhibits on one of its sides the whole alphabet (with the exception of the A, which has been broken off) in the debased Roman style of the sixth or following century. The carving of this *abecdarium* would appear to have been an afterthought, and executed probably a century or so later than the dedicatory DNI.

That in the British Isles, and indeed elsewhere, certain pillar-stones, or other monnments venerated by pagans, were in the early days of the Church preserved, and even devoted to Christian purposes, is a fact concerning which there can be no question. We read, for instance, that when St. Patrick on a certain occasion was travelling in Connaught he arrived at a place in the present county of Galway, near Lough Hackett, where he found the people worshipping three idols in the form of pillar-stones. These the saint did not destroy, but upon them he caused to be inscribed the names of the Redeemer—Jesus, Salvator, Soter. (See *Tripartite Life*, ii., c. 52.) Many other cases of similar import might, if necessary, be brought forward, but let one suffice for the present.

The county Dublin *bullân* rock is, as far as I know, the only lettered example of its class remaining in Ireland. (See Plate XVIII., fig. 2.)

Not far from Enniskillen, close to the western shore of Drumgay Lough, may be seen a block of hard, red sandstone, rudely quadrangular in form, measuring ten feet in length by six in breadth, and rising to the height of about four feet above the present level of the ground. (See Plate XVIII., fig. 2.) Upon its upper surface has been sunk a fine *bullân*, one foot four inches in diameter by eight inches in depth. This cavity, which presents all the appearance of having been worked out with a punch, is bowl-shaped in section, and in form highly symmetrical. Upon its base appears a cross, in Roman fashion, of the simplest kind. This figure, which has been well sunk into the stone, like the great majority of our early rock markings, must have been produced by aid of a pick. It is certainly not incised. The presence of a design of any kind within a *bullân* would indicate that the hollow had not been

intended to answer the purpose of a mortar. The cross here found is of the earliest class, and may be as old as the dawn of Christianity in Erin. It occurs on a monument distant from any cemetery or church site, and in a situation so lonely that few but herdsmen ever come that way. There is no ancient road, pathway, station, or holy well, in the neighbourhood. Tradition is silent concerning it, as also about a fractured block of sandstone which lies prostrate a few yards distant: the latter is, probably, a ruined *dallan*. I cannot but regard the presence of the cross here as very interesting and suggestive. If, as we have seen, during an early period of the Church in Ireland, as in England and upon the Continent, it was the custom, at least occasionally, to sanctify *quondam* idolatrous monuments, and utilize them for Christian purposes, may not the character of this *bullán* have been so transformed? We would seem to recognize at Drumgay a form of consecration differing only in style, certainly not in spirit, from that displayed at Kill-of-the-Grange—the usual symbol of Christianity instead of the dedicatory DOM for DOMINI, DOMINO, or DOM, for the words DEO OPTIMO MAXIMO.

Perhaps after the two inscribed *bulláns* just noticed, the ten-holed example of which I furnish a faithful drawing, is the most remarkable in Ireland. (See Plate XVII., fig. 2.) It stands on the shore of Upper Lough Macnean, and close to the ancient ruined parish church of Killinagh. The basins, which average about ten inches in diameter, are of various depths, and each is nearly filled with a somewhat circular or oval stone. There is a holy well close at hand, dedicated, like the church, to St. Brigid. The *bullán* is popularly known as "St. Brigid's stone," or altar. A lady, who from infancy had resided in the immediate neighbourhood, was good enough to inform me that she had been told when a child by her old nurse, who was a native of the district, that many years before this curious monument was known amongst the people as the "cursing-stone."

I heard the same story from a very old man who had lived all his life almost in sight of the time-stained gables of the neglected and mouldering *cill*. It was the custom, he said, when any of the neighbours had a grudge against a real or supposed enemy, and wished him harm, to proceed to the "altar" and anathematize him, at the same time turning the stones deposited in the basins. This practise, however, was not carelessly or lightly to be indulged in, as the curses, when undeserved, were sure to descend in full force on the person or property of their utterer. Surely this custom was at least un-Christian? It looks very like a relic of paganism, and, no doubt, so it was. We

know that in days anterior to Christianity a peculiar mode of cursing, in which the turning of stones was part of the proceedings, prevailed amongst the people of Erin. Sir Samuel Ferguson, in "The Burial of King Cormac," one of his charming and truly national poems, thus refers to this archaic system of anathematizing. The incident appears to have been recorded in one of our earliest manuscripts.

> "They loosed their curse against the king;
> They cursed him in his flesh and bones;
> And daily in their mystic ring
> They turned the maledictive stones."

The cursing- or swearing-stones of pagan days were, in all probability, plain. Those found on early Christian altars, as at Inismurray, are sometimes decorated with crosses, more or less chaste in design. Portion of the work on one of the Inismurray stones is of extremely early character, and reminds one most forcibly of a scribing which occurs on the interior of the pagan carn of Newgrange.

I may, perhaps, be permitted to remark, in passing, that in some of the primitive symbolic or decorative designs figured in our greater carns, we may discover the first germs of a style of art, vaguely named "Celtic," for the cultivation and development of which Erin, during the earlier ages of Christianity, and even down to the close of the twelfth century, was pre-eminently distinguished. (See Plate XVII., fig. 1.)

At a place called *Keim-an-eigh*, situated in an extremely wild district of the county Cork, may be seen a grand five-holed *bullân* rock. As at Killinagh, each of its basins contains a stone; but the purpose for which the latter had been used is now quite forgotten by the neighbouring people. A very absurd legend concerning them remains. They are supposed to have been originally rolls of butter which a certain woman had churned from milk dishonestly obtained. Fiachna, a local saint, is stated to have been highly indignant when, contrary to his exhortations, the ill-minded *vantigh* would still persist in supplying herself surreptitiously with the milk of other people's cows. He determined at length to make an example of the delinquent; and this he accomplished by turning her, as well as some butter she was carrying, into stone. A *dallan*, about six feet in height, rudely resembling a draped female figure, stands pretty close to the *bullân*. No doubt, in this real or fancied resemblance the transformation story originated. It is well worthy of remark that here, as at Drumgay, we find a pillar-stone in apparent connexion with the

bullán. I should mention that the basins are about one foot in diameter, and average four or five inches in depth. There is no sign of carving on the stones they contain, nor, as far as I am aware, has any device been noticed on similar objects which may be supposed to belong to pagan, or, perhaps, pre-historic times.

Enough has, probably, on this occasion been said in illustration of the larger *bullán* remains bearing in their cavities oval or rounded stones which, there is every reason to believe, were used by our ancient people for purposes not always clearly ascertained, but which would appear occasionally to have been connected with practices now considered eminently un-Christian.

Bullán rocks or boulders presenting basins in which supposed ceremonial stones are found occur in many parts of the country. But infinitely more numerous are plain empty cavities, which appear singly, at other times in groups, upon the one monument. It is probable that during the accidents of ages anything movable which had belonged to these examples has long disappeared. (See Plate XVII., fig. 4.) As a specimen of a plain, and, it may be presumed, denuded, *bullán*, I refer to one which may be seen on the river's bank, close to the famous Abbey of St. Fechin at Cong, Co. Galway. It is remarkable for the shallowness of some of its hollows, which scarcely exceeds a couple of inches. These, at least, could never have served as mortars.

An attempt to describe even one-third of the *bulláns* which remain in Ireland would necessarily require a considerable expenditure of time, nor could a single volume of moderate size contain all that might be brought forward in illustration of the several peculiarities which these antiquarian puzzles present.

In this sketchy Paper I have essayed to do little more than point to typical examples; yet I am not without hope that each known variety has been more or less referred to. The rock-basin or *bullán* is that confined to Ireland; it is represented in most countries which had been occupied by a race either wholly or in part Celtic. Probably, the most celebrated monument of this class is the famous "Coronation Stone" (the history of which has been traced for many centuries), now preserved in Westminster Abbey. I have not myself seen this wonderful relic; but, judging from a photograph, I do not hesitate to pronounce it a well-marked *bullán* of a type which is represented with us in more than one locality, and especially in Cleenish Island, Lough Erne, not far distant from Enniskillen. No suggestion like that which I now venture to make has hitherto, I believe, appeared; but then very few antiquaries or writers on the subject of British history would seem to have known anything about the character of our Irish *bulláns*.

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XXVII.

REPORT OF EXAMINATION OF THE MOSSES, HEPATICS, AND LICHENS OF THE MOURNE MOUNTAIN DISTRICT. By HENRY WILLIAM LETT, M.A., Dub.

[Read May 13, 1889.]

In the Spring of 1883, the Academy made me a grant of £10 for the purpose of investigating the Mosses and Lichens of the Mourne Mountains.

I have since then spent, from time to time, upwards of eight weeks collecting specimens of the cryptogamic flora of this district, and have now the honour of presenting a report of the result of my rambles and examinations.

In the district of the Mourne Mountains I have included from Slieve Donard, in the Co. Down, on the east, to Slieve Gullion, in Co. Armagh, on the west; and from Slieve Croob, in Co. Down, on the north, to Carlingford Mountain, in Co. Louth, on the south.

This area does not coincide with the botanical divisions of the Cybele Hibernica, but it is more natural and convenient, the whole district being quite distinct and separated by a long distance from any other range of mountains. It includes, roughly speaking, about 560 square miles, the distance from Slieve Donard to Slieve Gullion being 20 miles, and from Slieve Croob to Carlingford Mountain 28 miles.

Speaking petrologically, the range is composed of granite and basalt veins intruding through each other, and schist. There is no sandstone found within the limits, and no lime or kindred rocks, except at the extreme southern boundary, near the entrance to Carlingford Lough, where carboniferous limestone occurs in small quantity.

The scene of my investigations embraces varying elevations, from the sea level where St. George's Channel laves the bases of several of the mountains up to the highest of these (Slieve Donard) which, at not more than one mile from the coast, attains an elevation of 2786 feet, the highest point in Ulster. It is intersected by deep valleys and rocky glens with their streams, and contains several lakes and

mountain tarns, with a fair extent of woods. Being so diversified, it presents most favourable conditions for the growth of those plants which formed the object of my researches.

The following list contains 275 Mosses, 64 Hepatics, and 84 Lichens. Of these, 28 Mosses are not included in S. A. Stewart's "North-East of Ireland Flora." These are:—

Sphagnum	acutifolium,	*var.*	deflexum.
,,	,,	,,	purpureum.
,,	,,	,,	arctum.
,,	teres.		
,,	cuspidatum,	,,	plumosum.
,,	cymbifolium,	,,	congestum.
Dichodontium	pellucidum	,,	serratum.
Dicranella	heteromalla,	,,	sericea.
,,	,,	,,	stricta.
Dicranum	scoparium,	,,	alpestre.
,,	,,	,,	turfosum.
,,	,,	,,	spadiceum.
Campylopus	paradoxus.		
Pottia	littoralis.		
Grimmia	orbicularis.		
,,	obtusa.		
,,	,,	,,	subsimplex.
,,	affinis.		
,,	,,	,,	gracilescens.
Polytrichum	attenuatum.		
Pohlia (Webera)	acuminata.		
Thuidium	recognitum.		
Brachythecium	salebrosum.		
Hypnum	eugyrium.		
,,	stellatum,	,,	protensum.
Hylocomium	flagellare.		

All these, except the last (which has been omitted from Stewart's list by an oversight), are new to the North of Ireland, while the fol-

lowing 20 Mosses have been recorded by me for the first time from Ireland :—

Sphagnum acutifolium, *var.* ascendens.
,, ,, ,, luridus.
,, intermedium.
,, intermedium, ,, pulchrum.
,, molle, ,, mulleri.
,, rigidum.
Andreæa petrophila, ,, acuminata.
,, ,, ,, gracilis.
,, crassinervis, ,, huntii.
Mollia æruginosa, ,, ramosissima.
,, tortuosa, ,, angustifolia.
Dicranella heteromalla, ,, sericea.
Dicranum scoparium, ,, alpestre.
,, ,, ,, turfosum.
,, ,, ,, spadiceum.
Campylopus paradoxus.
Grimmia canescens, ,, ericodes.
Weissia intermedia.
Thuidium recognitum.
Brachythecium salebrosum.

It was my original intention to examine only the mosses and lichens, but the latter proving to be few in number, I thought it better to add the hepatics than to reserve them for a separate Report.

I may mention that the lichenologists who may visit the Mourne Mountains will be disappointed with the collections of lichens to be made on them. Many of the tops are sub-alpine, and various species which should be expected and were looked out for by myself, are remarkable for their absence, whilst even the most common sorts usually found in such places are scarce and poor. I say this, though aware that I may have overlooked many that will hereafter reward other investigators.

Nor do I think that, often as I have visited the breezy tops, or grubbed in the damp glens, or peered along the lonely rocks and bleak slopes of the Mournes, I have exhausted the stores of hepatics and mosses indigenous to the district.

My friend, the Rev. C. H. Waddell, M.A., Dub., accompanied me in many of my rambles. Besides finding most of the plants which I did he met with several varieties that did not fall to my lot.

My attention having been primarily directed to the plants peculiar to the elevated regions, many lowland plants, whose habitats are found within the district, have not been recorded as frequently as they might. Indeed, the lowland mosses whose localities I have noted, were in most cases picked up about the base of the mountains along the various paths by which I gained access to the range.

It is remarkable that, up till quite recently, cryptogamic botanists have never found their way into Mourne, in the south of the County of Down. And it is the more remarkable because Harris, in his "Description of the County Down," which was published in 1743, pointed to the Mourne Mountains as a likely habitat of botanical rarities. Yet the several botanists who assisted with the terrestrial cryptogams in Mackay's "Flora Hibernica," published in 1836, do not appear to have visited them, there being no reference to any locality in the district, so far as I can discover, in the descriptions of the musci, hepaticæ, and lichens in that volume.

Mr. Templeton of Belfast (who died previous to the publication of Mackay's "Flora") did collect some mosses among these mountains, though his work does not appear to have come under the notice of Dr. Mackay. For I have seen a presentation copy of the *Muscologiæ Hibernicæ Spicilegium*, by Dawson Turner, 1804, in which there is inscribed in the author's own writing, "John Templeton, Esq., with Mr. D. Turner's best respects and thanks for his assistance." This book is now in the possession of Mr. Robert M. Young, C.E., Belfast, who kindly lent it to me, and in it are some notes in Mr. Templeton's handwriting of the localities of the occurrence of seven mosses in the Mournes.

Dr. David Moore, in his "Synopsis of the Mosses of Ireland" (*Proc. R. I. A.*, vol. i., ser. II., p. 329, 1873), and in his "Report on Irish Hepaticæ" (*Proc. R. I. A.*, vol. ii., ser. II., p. 591, 1877), does not once mention the Mourne Mountains.

Mr. S. A. Stewart, in his "List of Mosses found in the North-east of Ireland," which was issued as an appendix to the Report of the Belfast Naturalists' Field Club for the year 1875, records 31 species as found in the Mournes. And in a supplement to a list of the mosses of the same district, printed for the above club in 1884, he added largely to his original list from the materials furnished by Mr. Waddell and myself. Both these lists were most carefully revised, and greatly

augmented, for the "Flora of the North-east of Ireland," published in 1888, edited by the same painstaking botanist, who again had the use of all Mr. Waddell's and my notes and *exsiccati*.

And as to the lichens, I know of only one solitary Mourne locality given in Leighton's "Lichen Flora of Great Britain and Ireland," and none whatever in Admiral Jones's collection of lichens in the Science and Art Museum, Dublin. This is the more curious, as Jones collected these plants so diligently in Co. Armagh, Co. Antrim, and near Donaghadee in Co. Down.

It may be interesting to compare the numbers of mosses and hepatics, found in the British Isles, and in Ireland alone, and in the North-east of Ireland, and in the Mourne district. The following Table will enable this to be done:—

SPECIES AND VARIETIES.	Mosses.	Hepatics.
The British Isles, ...	711	233
Ireland, as by the London Catalogue, . .	394	154
North-east of Ireland, ...	326	76
The Mourne District, ...	275	64

The nomenclature I have used in the mosses is that adopted by Dr. Braithwaite in his exhaustive "British Moss Flora," so far as it has yet appeared, and for the rest the nomenclature of Lindberg in his *Musci Scandinaviæ*.

In the hepatics I have chiefly used the names given in the same author's catalogue.

It remains for me to acknowledge with feelings of gratitude the assistance in determination of difficulties that I have received from time to time from Dr. Braithwaite, Mr. G. S. Holt of Manchester, Mr. D. M'Ardle of Glasnevin Botanic Garden, and Mr. Wm. West of Bradford. Whenever I applied to them they promptly and kindly afforded me the aid I sought.

MOSSES.

SPHAGNUM.

Sphagnum acutifolium, Ehrh.

Slieve Donard, Slieve Bignian, Hen Mountain, Shanlieve, Slieve Martin, Chimney Rock Mountain, Deer's Meadow, Anglesey Mountain, Clermont Mountain, Slieve Gullion, Pigeon Rock Mountain, Tollymore Park: H. W. L.

Sphagnum acutifolium, *var.* deflexum, Schpr.

Spinkwee River Glen: H. W. L. Very rare.

Sphagnum acutifolium, *var.* purpureum, Schpr.

Ballagh Park on Slieve Donard, White River Glen, Rocky Mountain near Hilltown, Slieve Martin, Knockbarragh Hill, Camlough Mountain: H. W. L. Ferry Hill, near Narrowwater: Rev. C. H. Waddell. Not common.

Sphagnum acutifolium, *var.* rubellum, Wils.

Slieve Donard, Slieve Dermot, Slievenabrock, top of Shanslieve, Anglesey Mountain, Clermont Mountain, Camlough Mountain, Hen Mountain: H. W. L. Knockbarragh Hill: Rev. C. H. Waddell. Rare.

Sphagnum acutifolium, *var.* luridum, Hübn.

By the Bloody Burn on Slieve Donard, Slieve Commedah, Spinkwee River Glen, Chimney Rock Mountain, Shanslieve: H. W. L. Not common. New to the Irish Flora.

Sphagnum acutifolium, *var.* arctum, Braithw.

1885, Top of Shanslieve, Carlingford Mountain, White River, Glen on Slieve Donard: H. W. L. Very rare.

Sphagnum acutifolium, *var.* ascendens, Braithw.

Shanslieve: H. W. L. New to Irish flora; very rare.

Sphagnum squarrosum, Pers.

Donard Demesne, near the Black Stairs on Slieve Donard, Slieve Commedah, Deer's Meadow: H. W. L. This moss is remarkably rare in the district. I found it very luxuriant in a small bog north of Hilltown.

Sphagnum squarrosum, *var.* teres, Augst.
Hen Mountain: H. W. L. Very rare; not recorded from any other locality in Ireland.

Sphagnum intermedium, Hffm.
Clermont Mountain, Deer's Meadow, in the lake on the Cove Mountain: H. W. L. Rare; new to Ireland.

Sphagnum intermedium, *var.* pulchrum, Lindb.
Deer's Meadow: H. W. L. Very rare; new to Ireland.

Sphagnum cuspidatum, Ehrb.
Speltha, Anglesey Mountain: H. W. L. Rosstrevor Mountain: Rev. C. H. Waddell. Very rare.

Sphagnum cuspidatum, *var.* plumosum, Nees.
Pools near summit of Camlough Mountain, and in a bog north of Hilltown: H. W. L. Very rare.

Sphagnum molle, Sull.
Rocky Mountain, near Hilltown, 1885, Hen Mountain, 1887: H. W. L. Very rare; not hitherto recorded from Ireland.

Sphagnum molle, *var.* mulleri, Sull.
Hen Mountain: H. W. L. Very rare; not hitherto recorded from Ireland.

Sphagnum rigidum, Schpr.
Slieve Donard, Chimney Rock Mountain, Kinahalla, Hen Mountain: H. W. L. Rare; new to Ireland.

Sphagnum rigidum, *var.* compactum, Brid.
Slieve Donard, Slieve Commedah, Kinahalla, Chimney Rock Mountain: H. W. L. Rare.

Sphagnum subsecundum, Nees.
Slieve Donard, Slieve Commedah, Tollymore Park, Rocky Mountain near Hilltown: H. W. L. Shanlieve, Knockbarragh. and Anglesey Mountain: Rev. C. H. Waddell. Common, and in many places abundant.

Sphagnum subsecundum, *var.* contortum, Schultz.
Slieve Donard, Eagle Mountain, Gruggandoo, Hen Mountain, Camlough Mountain: H. W. L. Common in springs on all the mountains.

Sphagnum subsecundum, *var.* obesum, Wils.

Bencrom: Rev. C. H. Waddell. Very rare.

Sphagnum subsecundum, *var.* auriculatum, Schpr.

Deer's Meadow, stream flowing from Off Mountain, 1884: H. W. L. Very rare.

Sphagnum tenellum, Ehrb.

Hen Mountain, Camlough Mountain: H. W. L. Very rare, 1886.

Sphagnum papillosum, Lindb.

Slieve Donard, Slieve Commedah, Windy Gap near the Eagle Mountain, Shanlieve, Rocky Mountain near Hilltown, Chimney Rock Mountain, Shanlieve, Hen Mountain: H. W. L. Common.

Sphagnum cymbifolium, Ehrh.

White River Glen, Tollymore Park, Shanlieve, Spinkwee River Glen, Rocky Mountain near Hilltown, Slieve Dermot, Anglesey Mountain: H. W. L. Knockbarragh Hill and Rosstrevor Mountain: Rev. C. H. Waddell. Common, but not abundant.

Sphagnum cymbifolium, *var.* congestum, Schimp.

Slievenamaddy, Spinkwee River Glen, Miner's Hill Glen: H. W. L. Rare.

ANDREÆA.

Andreæa petrophila, Ehrh.

Slieve Donard, on which it descends to 200 feet above the sea-level; Slieve Meel Beg, Rosstrevor Mountain near Cloughmore, Chimney Rock Mountain, Pierce's Castle, Tievedocharragh, Carlingford Mountain, Shanlieve: H. W. L. Slieve Croob: S. A. Stewart. Common, and very abundant on schist on the north slopes of the Mournes.

Andreæa petrophila, *var.* acuminata, Schpr.

Black Stairs on Slieve Donard, Slievenamaddy, Slievenabrock, Spinkwee River Glen: H. W. L. New to Ireland; rare.

Andreæa petrophila, *var.* gracilis, Schpr.

Slieve Donard, Slieve Commedah, Slieve Martin: H. W. L. North-east of Rosstrevor Mountain: Rev. C. H. Waddell. Very rare; new to Ireland.

Andreæa alpina, Turn.

Black Stairs on Slieve Donard, Slievenamaddy, Carlingford Mountain, Slievenabrock: H. W. L. Pigeon Rock Mountain: Rev. C. H. Waddell. Not common.

Andreæa rothii, W. and M.

Rocky Mountain, near Hilltown, Deer's Meadow, Castle Rocks on Slieve Commedah, Cove Mountain, Slieve Bignian, Chimney Rock Mountain; Slieve Meelbeg: H. W. L. Common on granite and schist, especially the latter.

Andreæa rothii, *var.* hamata, Lindb.

Slieve Commedah, Slieve Martin, Tievedocharragh: H. W. L. Very rare. Specimens from the last-mentioned locality have peculiar greenish tips to the leaves.

Andreæa falcata, Schpr.

Pierce's Castle: H. W. L. Rocky Mountain, near Hilltown: Rev. C. H. Waddell. Very rare.

Andreæa crassinervis, Bruch.

Slieve Commedah, Slieve Dermot: H. W. L. Shanlieve and Eagle Mountain: Rev. C. H. Waddell. Very rare.

Andreæa crassinervis, *var.* huntii.

Slieve Dermot, Slievenamaddy: H. W. L. Very rare; new to Ireland.

CATHARINEA.

Catharinea undulata, Web. and Mohr.

(Atrichum undulatum, P. Beauv.)

Slieve Donard, Tollymore Park, Slievenamaddy, The Castle Bog near Hilltown, Tievedocharragh, Anglesey Mountain, Moygannon Glen, Knockbarragh Hill, Crocknafeola, The Deer's Meadow, Camlough Mountain: H. W. L. Frequent throughout the district.

Oligotrichum incurvum (Huds.), Lindb.

(Oligotrichum hercynicum, Ehrh.)

Slieve Donard, Slievenamaddy, Slievenabrock, Bencrom, Miner's Hole River, Slieve Commedah, Pierce's Castle, Summit of Slieve Meel Beg, Speltha. Very fine in a disused gravel pit in Tollymore Park: H. W. L. Anglesey Mountain, Carlingford Mountain: Rev. C. H. Waddell. Frequent on sandy debris of granite and schist.

POLYTRICHUM.

Polytrichum subrotundum, Huds.

(Pogonatum nanum, P. Beauv.)

Slieve Donard, at 2000 feet, and on the lesser cairn; Slieve Commedah: H. W. L. Not common.

Polytrichum nanum, *var.* β longisetum, Hampe.

Mourne Mountains: Rev. C. H. Waddell. Very rare.

Polytrichum aloides, Hedw.

(Pogonatum aloides, P. Beauv.)

Along the fences of the Mountain-road between Rosstrevor and Hilltown, Narrow Water Park, Rosstrevor Mountain, the Black Stairs on Slieve Donard, Slieve Commedah, Knockbarragh Hill: H. W. L. Frequent in the district.

Polytrichum urnigerum, L.

(Pogonatum urnigerum, P. Beauv.)

The great cairn on the top of Slieve Donard, summit of Slieve Commedah, Rosstrevor Glen, Slieve Meel Beg, Moygannon Glen, The Deer's Meadow, top of Shanslieve: H. W. L. Frequent in the district.

Polytrichum alpinum, L.

(Pogonatum alpinum, Rohl.)

Carlingford Mountain, the lesser cairn on Slieve Donard, Slieve Commedah, The Deer's Meadow: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. Mourne Mountains, Templeton. Seems to be rather scarce in the district.

Polytrichum attenuatum, Menz.

Top of the Chimney Rock Mountain, 1883: H. W. L. Very rare.

Polytrichum gracile, Dicks.

On granite blocks, on the shore of Lough Shannagh, 1883: H. W. L., and Rev. C. H. Waddell. Woods at the foot of the Mourne Mountains, sub nomine, *P. pallidisetum*, T. Drummond. Though from these, the only records, this moss looks to be very rare, I have no doubt it occurs frequently throughout the district, and has been, and is overlooked from its great resemblance to small forms of *P. commune.*

Polytrichum piliferum, Schreb.

Spinkwee River Glen, Slievenamaddy, Donard Lodge Demesne, Slieve Commedah, Shores of Lough Shannagh, The Castle Bog-road, summit of Slieve Bignian, roadsides between Rosstrevor and Hilltown: H. W. L. Frequent, and in some places abundant.

Polytrichum juniperinum, Willd.

Anglesey Mountain: Rev. C. H. Waddell, Slieve Donard: S. A. Stewart. This moss seems to have been almost altogether overlooked in the district.

Polytrichum strictum, Banks.

Slieve Martin, July, 1884. On detached blocks of granite, somewhat to the west of the Black Stairs on Slieve Donard, 1885: H. W. L. This moss is mentioned by Templeton as having been found by him, but he gives no definite locality. Very rare.

Polytrichum commune, L.

The lesser cairn on Slieve Donard, Slievenamaddy, Slieve Gullion, Slieve Martin, Slievenabrock, Spinkwee River Glen, summit of Slieve Bignian. Very abundant, and of great length, on the northern slopes of the Butter Mountain: H. W. L. Frequent in the district.

FISSIDENS.

Fissidens incurvus, Starke.

Clermont Mountain, 1885: H. W. L. Very rare.

Fissidens bryoides, Hedw.

Near the Ivy Rock in Donard Lodge Demesne, Tollymore Park: H. W. L. Warrenpoint: Rev. C. H. Waddell. Not common in the district.

Fissidens osmundioides, Hedw.

The Black Stairs on Slieve Donard; very fine at this locality. Spinkwee River Glen, Pigeon Rock Mountain, Camlough Mountain, Carlingford Mountain, Anglesey Mountain: H. W. L. Slieve Croob: S. A. Stewart. Mourne Mountains: T. Drummond. Rather scarce.

Fissidens taxifolius, Hedw.

The Black Stairs on Slieve Donard, Tollymore Park, Anglesey Mountain: H. W. L. This moss is not common in the mountains, though very frequently met with in the lowlands of the district.

Fissidens adiantoides, Hedw.

Slieve Dermot, on blocks of schist on Rosstrevor Mountain. The Black Stairs on Slieve Donard, Anglesey Mountain, near Warrenpoint, Clonallon, Leitrim Hill near Hilltown, Fofanny, Slievenabrock, Pigeon Rock Mountain: H. W. L. Knockbarragh Hill, Moygannon Glen: Rev. C. H. Waddell. Frequent throughout the range.

LEUCOBRYUM.

Leucobryum glaucum, Schimp.

By the side of the Shimna River, under trees, in Tollymore Park; at 1600 feet on Slieve Donard; on detached basalt blocks on Thomas' Mountain, Tievedocharragh, Rocky Mountain, near Hilltown: H. W. L. Rosstrevor Mountain, Carlingford Mountain: Rev. C. H. Waddell. Slieve Donard: S. A. Stewart. This moss is nowhere abundant or luxuriant in the district; there are a few localities where the peculiar raised cushions are rather numerous, but they are of small size.

PLEURIDIUM.

Pleuridium subulatum, Rabenh.

Near Scarva: H. W. L. Clay banks near Warrenpoint: Rev. C. H. Waddell. This moss will probably be found hereafter in other suitable localities.

Pleuridium alternifolium, Rabenh.

Growing, mixed with *Fissidens incurvus*, on a shaded clay bank, by the side of a stream flowing north-east from Clermont Mountain: H. W. L. Bank near Warrenpoint: Rev. C. H. Waddell. Very rare.

DITRICHUM.

Ditrichum homomallum, Hampe.

The Deer's Meadow, Tollymore Park, the Black Stairs on Slieve Donard, by the side of a stream flowing north-east from Clermont Mountain, Tullybranigan, the Off Mountain, by the Golden River on Carlingford Mountain, the White River Glen: H. W. L. Rosstrevor Mountain, Anglesey Mountain: Rev. C. H. Waddell. Frequent in the district.

Ditrichum flexicaule, Hampe.

In a quarry near Carlingford: Rev. C. H. Waddell. Very rare in the district.

DICRANELLA.

Dicranella heteromalla, Sch.

Slieve Donard; Slieve Commedah, at 1900 feet; Ben Crom; Deer's Meadow; Windy Gap, near the Eagle Mountain; Tollymore Park; Rocky Mountain, near Hilltown; Knockbarragh Hill; Castle Bog: H. W. L. Carlingford Mountain, Anglesey Mountain: Rev. C. H. Waddell. Abundant on summit of Slieve Donard, at 1800 feet. Slieve Croob: S. A. Stewart. Abundant and pretty common.

Dicranella heteromalla, *var.* sericea, Sch.

Warrenpoint, Black Rocks on Slievenamaddy, shady bank in Tollymore Park: H. W. L. Very rare; new to Ireland.

Dicranella heteromalla, *var.* stricta, Sch.

Anglesey Mountain: Rev. C. H. Waddell. Very rare.

Dicranella cerviculata, Sch.

Slievenamaddy, Pigeon Rock Mountain, the Deer's Meadow: H. W. L. Gruggandoo: Rev. C. H. Waddell. Near the summit of Slieve Croob: S. A. Stewart. This moss is not common in the district: it is, without exception, always found on the peaty sides of drains in bogs.

ANISOTHECIUM.

Anisothecium rubrum, Lindb.

(Dicranella varia, Hedw.)

Rocky Mountain near Hilltown, Clermont Mountain, the Deer's Meadow: H. W. L. Near Warrenpoint, banks of Kilkeel River: Rev. C. H. Waddell. Not common.

Anisothecium rufescens, Lindb.

(Dicranella rufescens, Turn.)

Crown Fort, between Newry and Hilltown; banks of a stream on north of Anglesey Mountain: Rev. C. H. Waddell. Very rare.

Anisothecium squarrosum, Lindb.

(Dicranella squarrosa, Schrad.)

The White River Glen, Slieve Martin, Slieve Commedah at 1900 feet, Slievenamaddy, Shanslieve, the Yellow River above Kilbroney, Butter Mountain, Spinkwee River Glen: H. W. L. S. A. Stewart records a very large and beautiful form of this moss from Slieve Donard; I also found similar luxuriant plants of it in the White River Glen, which is bounded on the east by the precipices of Slieve Donard. Mr. J. Templeton mentions finding "*Dicranum squarrosum*, on dripping rocks, on the river-side running from Slieve Donard towards the Diamond Mountain"; this locality must be one of the springs at the head of the White River Glen, as no other place answers so well to the description. Frequent, but in small quantities.

BLINDIA.

Blindia acuta, B. and S.

Slieve Donard, Slieve Commedah, Slieve Gullion, Anglesey Mountain, Camlough Mountain: H. W. L. This moss occurs frequently, and in quantity, in the range from near the sea-level, in an old quarry close to the quay at Newcastle, up to 1200 feet, and is especially abundant where the rock is schist. Carlingford Mountain, Rosstrevor Mountain: Rev. C. H. Waddell. Slieve Croob: S. A. Stewart. Under the name of "*Grimmia acuta*," Mr. J. Templeton records this moss as "found in the hollow moist places about Slieve Donard, in fruit, June 20th, 1805."

CAMPYLOPUS.

Campylopus atrovirens, De Not.

Slieve Martin, Deer's Meadow, Slieve Commedah, Slieve Donard, Hen Mountain, Rocky Mountain near Hilltown, Carlingford Mountain: H. W. L. Rosstrevor, Anglesey Mountain: Rev. C. H. Waddell. This moss does not occur on Slieve Donard below 900 feet. Frequent on most of the mountains, but always barren. I found a slender bright green variety on the Hen Mountain, and a green form, with a reddish base to the stems, on rocks on Tievedocharragh.

Campylopus brevipilus, B. and S.

Near the Black Stairs on Slieve Donard, Slievenabrock, Slieve Commedah, Slieve Martin, Shanslieve: H. W. L. Not at all common; but it may have been overlooked owing to its general resemblance to *C. flexuosus*.

Campylopus setifolius, Wils.

The Black Stairs and by the side of Amy's River on Slieve Donard, Slieve Commedah, Slievenabrock, Pigeon Rock Mountain: H. W. L. Rare.

Campylopus fragilis, B. and S.

Slievenabrock, the Black Stairs on Slieve Donard, Chimney Rock Mountain, Shanslieve, Slieve Dermot, Slieve Bearna, Tievedocharragh, Miner's Hole River Glen, Spinkwee River Glen, Anglesey Mountain, Camlough Mountain: H. W. L. Slieve Croob: S. A. Stewart. Frequent in fine fruit.

Campylopus pyriformis, Brid.

Slieve Donard, Slieve Bearna, Slieve Dermot, Shanslieve, Tievedocharragh, the Black Rocks on Slievenamaddy, the Deer's Meadow, Slieve Gullion: H. W. L. Rather scarce throughout the range.

Campylopus flexuosus, Brid.

Bencrom, Slieve Commedah, Slieve Dermot, Donard Lodge Demesne, Slievenabrock, Bloody Burn Glen, Carlingford Mountain, Slieve Gullion, Slieve Meelmore, Slieve Martin, Butter Mountain, Cove Lake, Pigeon Rock Mountain, Slieve Bignian, Chimney Rock Mountain, Camlough Mountain: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. This moss is common and abundant in the district.

Campylopus flexuosus, *var.* β paludosus, Sch.

The Deer's Meadow: H. W. L. Rare, and not hitherto recorded from Ireland, but perhaps confounded with *C. flexuosus* of the normal type, of which many authorities consider it merely a form.

DICRANOWEISSIA.

Dicranoweissia cirrata, Lindb.

(Weissia cirrata, Hedw.)

Slieve Donard, Slieve Commedah, Shanlieve, Pierce's Castle, Tievedocharragh, Gruggandoo, Altataggart, Bencrom, Anglesey Mountain, Tollymore Park: H. W. L. Local, and not abundant.

DICRANUM.

Dicranum majus, Sm.

Tollymore Park and Donard Demesne: H. W. L. Rosstrevor Wood: Rev. C. H. Waddell. "Tollymore Park, at the waterfall": J. Templeton. This moss is not common in the district.

Dicranum bonjeanii, De Not.

Slieve Dermot, top of Hen Mountain, Thomas Mountain, Slievenabrock, Slieve Bignian, Donard Lodge, Demesne, Clermont Mountain, Camlough Mountain: H. W. L. Under the name of *D. undulatum*, J. Templeton notes this moss from "Tullamore Park, near the Waterfall."

Dicranum scottii, Turn.

Shanlieve, Hen Mountain near Hilltown, on detached granite blocks on Slieve Commedah: H. W. L. Very rare. A specimen of this moss is in Thomas Drummond's exsiccati in the Belfast Museum, marked "Mourne Mountains."

Dicranum fuscescens, Turn.

On shady rocks, on the north-east side of Slieve Bignian: H. W. L. Very rare. Bencrom, Shanlieve: Rev. C. H. Waddell.

Dicranum scoparium, Hedw.

On stones and trees in Rosstrevor Wood, top of Chimney Rock Mountain, smaller cairn on summit of Slieve Donard, Anglesey Mountain, Tievedocharragh, Knockbarragh Hill, Tollymore Park, Donard Demense: H. W. L. Common. "Tullamore Park, on trees, June, 1805. A variety from Carlingford Mountain, 24th May, 1804": J. Templeton.

Dicranum scoparium, *var.* ε orthophyllum, Brid.

On the lesser cairn on the summit of Slieve Donard, on boulders in Donard Demesne, Slievenamaddy, Slievenabrock, Butter Mountain, shady rocks in Tollymore Park, Clermont Mountain: H. W. L. Not common. Rosstrevor Wood: Rev. C. H. Waddell.

Dicranum scoparium, *var.* β alpestre, Hueben.

Slieve Donard at 2000 feet, Slieve Commedah, Slievenabrock, Slieve Martin: H. W. L. Rare. Not before recorded from Ireland.

Dicranum scoparium, *var.* δ turfosum, Milde.

Slievenabrock: H. W. L. Very rare. New to Ireland.

Dicranum scoparium, *var.* spadiceum, Zettad.

(*Vide* Braithwaite's "British Moss-Flora," vol. I., p. 149.)

Clermont Mountain, 26th June, 1885: H. W. L. New to Ireland.

DICHODONTIUM.

Dichodontium pellucidum, Schpr.

In crevices of rocks in the stream at the Black Stairs on Slieve Donard, in Tollymore Park on wet rocks by the side of the River Shimna, Slievenabrock, Omeath Glen, Clermont Mountain: H. W. L. Rare.

Dichodontium pellucidum, *var.* serratum, Schpr.

Slievenabrock, Tollymore Park,: H. W. L. Very rare.

Dichodontium pellucidum, *var.* fagimontanum, Brid.

At the head of a stream on Slieve Martin, which flows towards Rosstrevor: H. W. L. Very rare.

ONCOPHORUS.

Oncophorus striatus, Lindb.

(Rhabdoweissia fugax, Hedw.)

Slievenabrock, black rocks on Slievenamaddy, Carlingford Mountain: H. W. L. Rare. J. Templeton records this as *Grimmia striata* from the Mourne Mountains.

Oncophorus crispatus, Lindb.

(Rhabdoweissia denticulata, Brid.)

The Black Stairs on Slieve Donard, Slievenabrock: H. W. L. Two Mile River on Carlingford Mountain: Rev. C. H. Waddell. Very rare.

CERATODON.

Ceratodon purpureus, Brid.

This is the most ubiquitous and frequent moss found in the district. Very common and abundant from the sea-level, among the sand-dunes of Newcastle, to the highest point of Slieve Donard: H. W. L.

POTTIA.

Pottia truncatula, Lindb.

Carlingford Mountain, banks of the Shimna River near Newcastle: H. W. L. Warrenpoint: Rev. C. H. Waddell. Although recorded from so few localities, this moss is common throughout the district.

Pottia littoralis, Mitt.

Carlingford Mountain: Rev. C. H. Waddell. Very rare.

Pottia intermedia, Fuernr.

On the roadside near Kilmore Church close to Crossgar: H. W. L. Rare, but probably overlooked by Co. Down moss collectors. Templeton notes this plant, under the name *Gymnostomum obtusum*, as "common on ditches near Killyleagh," which place is not far from the Crossgar locality.

TORTULA.

Tortula ericæfolia, Lindb.

Carlingford Quarry, with young fruit: Rev. C. H. Waddell. Very rare.

Tortula aloides, De Not.

Wall at Narrowwater: Rev. C. H. Waddell. Very rare.

Tortula muralis, Hedw.

Knockbarragh, Hilltown, Analong, the Deer's Meadow. A large variety occurs between Hilltown and Tollymore: H. W. L. This moss is abundant wherever a suitable habitat occurs, but such walls are few amongst the mountains.

Tortula ruralis, Ehrh.

Very abundant among the sand-hills at Newcastle, where also the *var. arenicola* is frequent, on walls at Carlingford: H. W. L. Scarce elsewhere in the district.

Tortula papillosa, Wilson.

On aged white thorns, and elder near Loughbrickland: H. W. L. Very rare; but has likely been overlooked.

Tortula montana, Lindb.

(Tortula intermedia, Brid.)

Wall at Warrenpoint: Rev. C. H. Waddell. Very rare.

Tortula subulata, Hedw.

Analong, Knockbarragh Hill, on the side of road between Hilltown and Tollymore Park, Loughbrickland: H. W. L. Near Warrenpoint, Omeath: Rev. C. H. Waddell.

MOLLIA.

Mollia microstoma, Lindb.

(Gymnostomum microstomum, Hedw.)

Omeath Glen, near the sea at the Bloody Bridge: H. W. L. Near Warrenpoint: Rev. C. H. Waddell. Sandhills near Newcastle: S. A. Stewart. Very rare.

Mollia viridula, Lindb.

(Weissia controversa, Hedw.)

Warrenpoint, banks of Moygannon River, Tullybranigan Hill, Carlingford Mountain: H. W. L. Common and abundant in all suitable habitats in the district.

Mollia littoralis, Mitt.

(Trichostomum mutabile, Brach.)

Carlingford Mountain, Omeath Glen, Kinahalla, on the north face of the Black Rock in the town of Newcastle: H. W. L. Rare.

Mollia æruginosa, Lindb.

(Gymnostomum rupestre, Schwg.)

Tollymore Park, near Omeath Waterfall: H. W. L. Rare.

Mollia æruginosa, *var.* ramosissima, B.S.

(Gymnostomum rupestre, *var.* ramosissimum, Sch.)

On a wall under one of the bridges over the Shimna River, in Tollymore Park: H. W. L. Very rare, and not before recorded from Ireland.

Mollia tenuirostris, Lindb.

(Didymodon cylindricus, Brach.)

The Black Stairs, on Slieve Donard, Slieve Bignian, Pigeon Park Mountain, Tollymore Park, Slievenabrock, the Black Rocks on Slievenamaddy, Slieve Dermot, park wall near Bryansford village: H. W. L. Rosstrevor Mountain, Carlingford Mountain, Omeath, Cove Mountain, Rocky Mountain near Hilltown: Rev. C. H. Waddell.

Mollia verticillata, Lindb.

(Eucladium verticillatum, L.)

Close by the Waterfall at the Black Stairs on Slieve Donard: H. W. L. Very rare, and in small quantities.

Mollia inclinata, Lindb.

(Barbula inclinata, Schwg.)

In crevices of rocks close to the sea at Analong, mostly in company with *Grimmia maritima:* H. W. L. Sandy banks and rocks by the sea-shore at Omeath: Rev. C. H. Waddell; by whom it was found also at Groomsport in the county of Down, being its first record from Ireland.

Mollia tortuosa, Schrank.

(Barbula tortuosa, L.)

Thomas Mountain, Carlingford Mountain, on a wall west of Bryansford, Slievenabrock, Omeath River Glen: H. W. L. Rosstrevor Mountain: Rev. C. H. Waddell. Rare.

Mollia tortuosa, *var.* β angustifolia, Braith.

On a wall west of Bryansford: H. W. L. Very rare and scarce. Not before recorded from Ireland.

BARBULA.

Barbula unguiculata, Dill.

Shanslieve, Tievedocharragh, Tollymore Park, Analong, Altaggart, Warrenpoint, Bryansford, Moygannon Glen: H. W. L. Not common or abundant.

Barbula brevifolia, Lindb.

(Trichostorum tophaceum, Brid.)

Moygannon Glen, Knockbarragh, Bloody Bridge near Newcastle, encrusted with lime in quarry near Carlingford, near the sea at Analong, Tollymore Park: H. W. L.

Barbula curvirostris, Lindb.

(Gymnostomum curvirostrum, Ehrh.)

Moygannon Glen, Omeath Glen, Cove Mountain: H. W. L. Rare.

Barbula fallax, Hedw.

Knockbarragh Hill, Omeath Glen, Moygannon Glen: H. W. L. Anglesey Mountain, Greencastle: Rev. C. H. Waddell. Rare.

Barbula spadicea, Mitt.

Wall of a bridge in Tollymore Park, Newcastle, wall at Narrow-water, Moygannon Glen: H. W. L. Bank of Omeath River: Rev. C. H. Waddell. Rare.

Barbula cylindrica, Tayl.

Roadside near Aghaderg School-house at Loughbrickland, Dromantine: H. W. L. In fine fruit at Omeath Waterfall: Rev. C. H. Waddell. Very rare.

Barbula revoluta, Schrader.

Wall near Warrenpoint, wall at Bryansford: H. W. L. Rather scarce.

Barbula convoluta, Hedw.

Bridge in Tollymore Park, wall at Tullybranigan, wall at Narrow-water: H. W. L. Scarce.

Barbula rubella, Mitt.

(Didymodon rubellus, B. and S.)

On a wall north of the Deer's Meadow, at Brook Cottage near Newcastle, on the Black Rock in the town of Newcastle, Moygannon Glen, Loughbrickland: H. W. L. Anglesey Mountain, Narrowwater: Rev. C. H. Waddell. Is not common or abundant in the district.

CINCLIDOTUS.

Cinclidotus fontinaloides, P. B.

Abundant in the rocky bed of the Bann River between Hilltown and the Hen Mountain: H. W. L. This moss is also abundant in the Lagan River near Maralin, just outside the district.

LEERSIA.

Leersia contorta, Lindb.

(Encalypta streptocarpa, Hedw.)

Walls of the ice-house on Slieve Donard, wall by the side of the road at the Ferry Hill, near Narrowwater; very abundant and luxuriant on walls west of the village of Bryansford, wall in Ravensdale Park near Jonesborough, wall of Scarvagh Demesne between Loughbrickland and Scarvagh: H. W. L. On granite on the Rocky Mountain near Hilltown: Rev. C. H. Waddell. Rare in the district.

WEBERA.

Webera sessilis, Lindb.

(Diphysium foliosum, L.)

Slieve Donard, summit of Slieve Bignian, Pigeon Rock Mountain, Slieve Commedah, Slievenamaddy, Slievenabrock, Carlingford Mountain, Camlough Mountain: H. W. L. Banks of the Golden River on Carlingford Mountain, along the sides of the Bloody Burn: Rev. C. H. Waddell. Abundant in all these localities, and in fine fruit. By an oversight, the "Flora of the North-east of Ireland" mentions this as "rare and barren."

GRIMMIA.

Grimmia pruinosa, Wils.

Rocks on Slieve Donard: H. W. L. Very rare; only one small tuft was found in 1883.

Grimmia apocarpa, L.

Analong, Rosstrevor Glen, Narrowwater Demesne, Camlough Mountain, Kinahalla; a long green form on shady rocks, by the side of the Shimna River, in Tollymore Park: H. W. L. Not common in the district.

Grimmia apocarpa, *var.* rivulare, Bridel.

Yellow Water River: H. W. L. Rare. Stream on north-east of Rosstrevor Mountain, and Knockbarragh Hill: Rev. C. H. Waddell.

Grimmia maritima, Turn.

Analong, Bloody Bridge, Maggie's Leap, Armar's Hole: H. W. L. Omeath, Rosstrevor, Warrenpoint: Rev. C. H. Waddell. Abundant on maritime rocks.

Grimmia orbicularis, B. and S.

Top of a dry-built stone wall, on the Spelga Mountain: H. W. L. Very rare; but most likely present in other localities, having been confounded with *G. pulvinata.*

Grimmia pulvinata, Dill.

Rocky Mountain near Hilltown, Analong, the Deer's Meadow, Donard Lodge Demesne, wall near Bryansford, Bridge of Kinahalla: H. W. L. Not common or abundant.

Grimmia decipiens, Lindb.

(Grimmia schultzii, Brid.)

Stones in fence between Hilltown and Bryansford, Ballagh Park on Slieve Donard, Analong, Tollymore Park, Slievenamaddy, Tievedocharragh, the Black Stairs on Slieve Donard, Clermont Mountain: H. W. L.

Grimmia decipiens, *var.* robusta, Ferg.

Rocks above the ice-house on Slieve Donard, rocks by stream on Slievenamaddy, on stones of dry wall on the Spelga Mountain: H. W. L. Very rare.

Grimmia funalis, Schwg.

Slieve Donard, Slievenabrock, Slieve Dermot: H. W. L. Rare. I have a remarkable lax form from the Black Stairs and White River Glen, Slieve Donard.

Grimmia trichophylla, Grev.

Butter Mountain, near Fofanny Schoolhouse, Ballagh Park on Slieve Donard, Slievenabrock, close to the sea at Maggie's Leap, Altaggart near Hilltown, Camlough Mountain: H. W. L. Analong: Rev. C. H. Waddell.

Grimmia donii, Sm.

In crevices of schist blocks on coping of dry-built walls between Tollymore Park and Slievenamaddy, the Ballagh Park on Slieve Donard, on a granite block between Slieve Martin and Kilbroney bog, on the north-east slope of Camlough Mountain: H. W. L. Rare.

Grimmia ovata, W. and M.

The Black Stairs on Slieve Donard: H. W. L. A barren state. Very rare.

Grimmia elliptica, Arn.

(Racomitrium ellipticum, Turn.)

The Black Stairs on Slieve Donard, Slievenabrock, Spinkwee River Glen, the Black Rocks on Slievenamaddy: H. W. L. This moss is rare throughout the range, and where found is not abundant. In Templeton's Herbarium, in the Belfast Museum, there is a specimen marked from the "Mourne Mountains."

Grimmia acicularis, C. Muell.

(Racomitrium aciculare, L.)

Rocky bed of the Rosstrevor River at Kilbroney, Spinkwee River Glen, Slieve Martin at 1500 feet, on stones in Donard Lodge Demesne, Tievedocharragh, very fine on schist in the White River Glen, Chimney Rock Mountain, Slieve Meel Beg, Windy Gap near the Eagle Mountain, Tollymore Park, Analong River Glen, the Off Mountain, top of Slieve Bignian, Camlough Mountain, Anglesey Mountain, Slieve Gullion: H. W. L. Near Clonallan: Rev. C. H. Waddell. Common throughout the whole range.

Grimmia aquatica, C. Muell.

(Racomitrium protensum, A. Braun.)

On schist on Thomas Mountain, the Black Stairs on Slieve Donard, Slievenamaddy, Slieve Meel Beg, rocks in the River Shimna in Tollymore Park: H. W. L. Rosstrevor Wood, Knockbarragh Hill, and near Hilltown: Rev. C. H. Waddell. This moss is rare in the district. Mr. T. Drummond found it in the "Mourne Mountains."

Grimmia microcarpa, Gmel.

(Racomitrium sudeticum, Funck.)

Slieve Commedah, top of Shanlieve, Spelga, Slieve Gullion, Thomas Mountain, and the Black Stairs on Slieve Donard: H. W. L. This moss is rare throughout the range.

Grimmia heterosticha, C. Muell.

(Racomitrium heterostichum, Hedw.)

Slievenabrock, Slieve Donard (at the Black Stairs and on the Great Cairn), Tievedocharragh, Knockbarragh, Tollymore Park, Rosstrevor Wood, Anglesey Mountain, Golden River on Carlingford Mountain, Camlough Mountain: H. W. L. Common all over the range.

Grimmia obtusa, Lindb.

(Racomitrium heterostichum, *var.* gracilescens, Br.)

Shanslieve, Slieve Donard, Slievenamaddy, Slieve Bignian: H. W. L. Very rare.

Grimmia obtusa, *var.* β subsimplex, Lindb.

The black rocks on Slievenamaddy, 1885: H. W. L. This rare and beautiful moss, which has been only once before found in Ireland, might at first sight be mistaken for *Grimmia fascicularis*, from which Dr. Braithwaite has shown me that it is distinct, and that my specimen is the true plant.

Grimmia affinis, Lindb.

(Racomitrium heterostichum, *var.* alopecurum, Huebn.)

Thomas Mountain and the Great Cairn on Slieve Donard, Miner's Hole River Glen, Slievenabrock, summit of Shanslieve, summit of Slieve Bignian, Rosstrevor Mountain, the Black Rocks on Slievenamaddy, Slieve Commedah: H. W. L. This moss is frequent among the range. Carlingford Mountain: Rev. C. H. Waddell.

Grimmia affinis, *var.* gracilescens, Lindb.

A single tuft in a specimen of *Grimmia obtusa* from the Lesser Cairn on Slieve Donard, and also in a gathering from Shanslieve: H. W. L. Very rare; but probably has been overlooked.

Grimmia fascicularis, C. Muell.

(Racomitrium fasciculare, Brid.)

Inside the roof of the well on the summit of Slieve Donard, Tievedocharragh, Ferry Hill near Fathom: H. W. L. Not common in the district.

Grimmia hypnoides, Lindb.

(Racomitrium lanuginosum, Brid.)

Slieve Martin, most abundant on the top of Slieve Meel Beg, Slieve Commedah, the Lesser Cairn on Slieve Donard (this moss is scarce on the high region of this mountain), top of Chimney Rock Mountain, Bencrom, on walls near the Deer's Meadow, Tievedocharragh: H. W. L. I got a form with falcate leaves in this last locality. Anglesey Mountain, Camlough Mountain, Rosstrevor Mountain: Rev. C. H. Waddell.

Grimmia canescens, C. Muell.

(Racomitrium canescens, Hedw.)

Sandhills near Newcastle, roadside between Fofanny and Bryansford, Windy Gap near Eagle Mountain, Butter Mountain, Spinkwee River Glen, the Deer's Meadow, Anglesey Mountain: H. W. L. Common throughout the range.

Grimmia canescens, *var.* ericoides, C. Muell.

(Racomitrium canescens, *var.* ericoides, Schraed.)

Butter Mountain, Anglesey Mountain. Very rare.

GLYPHOMITRIUM.

Glyphomitrium daviesii, Brid.

The Rev. C. H. Waddell and I found a very small quantity of this plant on basalt at the Black Stairs on Slieve Donard. I afterwards got it in very fine fruit, and in plenty, on schist blocks on the east slope of this mountain. These are the only localities for this moss in the district.

Glyphomitrium polyphyllum, Mitt.

(Ptychomitrium polyphyllum, Fuerne.)

On stones in Rosstrevor River, the Deer's Meadow, top of Chimney Rock Mountain, Slieve Donard, on detached blocks in Donard Demesne, on stones among the sandhills at Newcastle, Carlingford Mountain, Slieve Gullion: H. W. L. Warrenpoint, Anglesey Mountain, Rev. C. H. Waddell. Of frequent occurrence in the district.

ANŒCTANGIUM, Hedw

Anœctangium mougeotii, Lindb.

(Amphoridium mougeotii, B. and S.)

The Black Rocks on Slievenamaddy, summit of Slieve Bignian, the Black Stairs on Slieve Donard, Pigeon Rock Mountain, Cove Mountain, in the Glen near the Waterfall and on a rock close to the sea at Omeath: H. W. L. Tollymore Park: Rev. C. H. Waddell. Rare.

PLEUROZYGODON, Lindb.

Pleurozygodon compactum, Lindb.

(Anœctangium compactum, Sch.)

Wet rocks at the head of the White River Glen on Slieve Commedah, Slievenamaddy: H. W. L. Very rare, and scarce.

ZYGODON, Hook. Tayl.

Zygodon viridissimus, Dicks.

On trees in Tollymore Park, and near the village of Bryansford: H. W. L. Near the waterworks at Rosstrevor: Rev. C. H. Waddell. Not common.

Zygodon stirtoni, Schpr.

(Zygodon viridissimus, *var*. rupestris, Lindb.)

On the wall of the Bloody Bridge, near Newcastle: on a dry built wall, near Analong: H. W. L. Very rare.

ORTHOTRICHUM, Hedw.

Orthotrichum saxatile, Brid.

(Orthotrichum anomalum, Hedw.)

Warrenpoint: Rev. C. H. Waddell. Very rare.

Orthotrichum affine, Schrad.

Donard Lodge Demesne, Tollymore Park, Rademon Woods, near Loughbrickland: H. W. L.: on thatch of roof of house at Warrenpoint: Rev. C. H. Waddell. Frequent in these localities.

Orthotrichum stramineum, Hornsh.

Growing mixed with *O. lyellii*, on a beech-tree in Tollymore Park: Rev. C. H. Waddell. Very rare.

Orthotrichum diaphanum, Schrad.

Donard Lodge Demesne, on rocks and trees at Analong near the Rectory, near Loughbrickland: H. W. L. At Warrenpoint, on thatch of roof, and rocks near the sea: Rev. C. H. Waddell. Scarce.

Orthotrichum lyellii, H. and T.

Trees in Bryansford village opposite the Hotel, in fruit in Finnebrogue Demesne; and in abundance, but barren on a few trees in the neighbourhood of Loughbrickland: H. W. L. Tollymore Park: Rev. C. H. Waddell. Rare.

Orthotrichum striatum, Hedw.

(Orthotrichum leiocarpum, B. and S.)

Tollymore Park, on a tree near the river Bann at Clonduff Old Church, Loughbrickland: H. W. L. Rare.

Orthotrichum rivulare, Turn.

Near Brook Cottage Newcastle: H. W. L. Rademon near Crossgar: S. A. Stewart. Very rare.

WEISSIA, Ehrh.

Weissia bruchii, Lindb,

(Ulota bruchii, Hornsh.)

I found one tuft in fruit in Rosstrevor Wood: H. W. L. Tollymore Park, Rosstrevor Wood: Rev. C. H. Waddell.

Weissia ulophylla, Lindb.

(Ulota crispa, Hedw.)

Tollymore Park, Rosstrevor Wood, Rademon Woods: H. W. L. Rare.

Weissia ulophylla, *var.* β intermedia, Schpr.

(Ulota intermedia, Schpr.)

On beech, sycamore, and ash-trees, in Tollymore Park, and Donard Lodge Demesne. H. W. L. Rare.

Weissia phyllantha, Lindb.

(Ulota phyllantha, Brid.)

Tollymore Park, stones in wall near the sea at Analong, wall near the sea at Narrowwater Castle, tree between Hilltown and Bryansford. H. W. L. Rosstrevor Wood: Rev. C. H. Waddell.

FUNARIA, Schreb.

Funaria hygrometrica, L.

Crocknafeola, the Stone Bridge in Donard Lodge Demesne, Golden River on Carlingford Mountain: H. W. L. Occurs frequently throughout the range.

Funaria obtusa, Lindb.

(Entosthodon ericetorum, Bals.)

Tollymore Park, Amy's River on Slieve Donard, Moygannon Glen, Anglesey Mountain: H. W. L. Rare.

Funaria templetoni, Smith.

(Entosthodon templetoni, Hook.)

Rosstrevor Mountain, Moygannon Glen, the Black Stairs on Slieve Donard, Slievenabrock, Pigeon Rock Mountain, Anglesey Mountain: H. W. L. Golden River on Carlingford Mountain, Yellow Water River between Rosstrevor and Hilltown: Rev. C. H. Waddell. "Mourne Mountains, near Newcastle:" T. Drummond. Frequent throughout the range.

PHYSCOMITRIUM, L.

Physcomitrum pyriforme, L.

In a bog near Loughbrickland: H. W. L. Warrenpoint: Rev. C. H. Waddell. Rare, but likely has been overlooked, as it is not readily recognized except when in fruit.

SPLACHNUM, L.

Splachnum pedunculatum, Lindb.

(Splachnum sphæricum, L. fil.)

On the slope of Slieve Bignian in the Happy Valley, Tievedocharragh, the Deer's Meadow, near the Castle Bog, Slieve Lough Shannagh: H. W. L. Bog between Hilltown and Rosstrevor, Eagle Mountain, Kilkeel River Glen: Rev. C. H. Waddell. Slieve Croob: S. A. Stewart. Frequent.

Splachnum ampullaceum, L.

Rocky Mountain, near Hilltown, the Deer's Meadow: H. W. L. Very rare.

TETRAPLODON, Br. Eur.

Tetraplodon bryoides (Zoeg), Lindb.

(Tetraplodon mnioides, Hedw.)

Abundant, and in fine fruit in September, 1883, on the lesser cairn on summit of Slieve Donard; Crocknafeola: H. W. L. Rocky Mountain, 800 feet: Rev. C. H. Waddell. Summit of Slieve Bignian: S. A. Stewart.

BARTRAMIA, Hedw.

Bartramia ithyphylla, Brid.

Slievenabrock, North-west of the Castle Bog, Leitrim Hill near Hilltown, Carlingford Mountain: H. W. L. Rosstrevor Wood: Rev. C. H. Waddell. Rare.

Bartramia pomiformis, L.

Slievenabrock, Slieve Meel Beg, Spinkwee River Glen, White River Glen, Slieve Bignian, Camlough Mountain: H. W. L. Abundant on schist rocks, and north slopes of the range. This moss occurs also in very small quantity at Loughbrickland, at the north edge of the district. Ferryhill near Omeath, Clonallon, Knockbarragh: Rev. C. H. Waddell. In crevices of granite rocks on Slieve Donard: S. A. Stewart.

Bartramia fontana, Swartz.

(Philonitis fontana, L.)

The Black Stairs on Slieve Donard, very fine on Slieve Commedah, Yellow River near Killroney Bog, Slieve Meel Bog, Leitrim Hill near Hilltown, Butter Mountain, Cove Mountain, Anglesey Mountain, Golden River on Carlingford Mountain: H. W. L. Rosstrevor Mountain: Rev. C. H. Waddell. Very abundant in all suitable habitats throughout the range.

Bartramia fontana, Swartz, *var.* falcata.

(Philonitis fontana, *var.* falcata, Dehot.)

Wet clay banks on stream on Anglesey Mountain: H. W. L. Very rare.

Bartramia calcarea, B. and S.

(Philonitis calcarea, B. and S.)

I have collected this in company with the Rev. C. H. Waddell, in Sandstone quarry, at Kilwarlin, just outside the boundary of the district.

BREUTELIA, Schpr.

Breutelia chrysocoma, Schpr.

(Breutelia arcuata, Dicks.)

The Deer's Meadow, Tollymore Park, Bencrom, Slieve Martin, Chimney Rock Mountain, the Windy Gap near the Eagle Mountain, Spinkwee River Glen, Rocky Mountain, near Hilltown, summit of Slieve Bignian, Camlough Mountain, Carlingford Mountain: H. W. L. Ferry Hill, near Omeath, Kilroney Red Bog: Rev. C. H. Waddell. This beautiful moss is of frequent occurrence, and luxuriant growth throughout the range.

POHLIA, Schpr.

Bohlia acuminata, Hoppe.

(Webera acuminata, Hoppe.)

The Black Stairs, on Slieve Donard, Speltha: H. W. L. Very rare.

Pohlia elongata, Hedw.

(Webera elongata, Dicks.)

The Black Stairs on Slieve Donard, summit of Slieve Commedah, Lesser Cairn on Slieve Donard, the Black Rocks on Slieve Namaddy: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. Rare.

Pohlia nutans, Schreb.

(Webera nutans, Schreb.)

Slieve Commedah, Spelga, Tievedocharragh, Slieve Martin, Chimney Rock Mountain, Pierce's Castle, Anglesey Mountain, Slieve Meel Beg, the Deer's Meadow, Slieve Donard, on shady sides of Bloodyburn Glen with bright red capsules: H. W. L. Warrenpoint: Rev. C. H. Waddell. Ascending to 2000 feet on Slieve Donard: S. A. Stewart.

Pohlia cruda, Lindb.

(Webera cruda, Schreb.)

The Black Stairs, on Slieve Donard, Oct., 1884: H. W. L. Very rare.

Pohlia annotina, L.

(Webera annotina, Hedw.)

Slieve Donard above the Black Stairs, Slieve Bignian: H. W. L. Very rare.

Pohlia albicans, Lindb.

(Webera albicans, Wahl.)

Abundant at and by the streamlet above the Black Stairs, on Slieve Donard, inside roof of wayside well near Fofanny, Banks of the Shimna River, Slieve Gullion: H. W. L. Anglesey Mountain, Yellow Water River near Kilbroney Bog: Rev. C. H. Waddell. Not common.

BRYUM, Dill.

Bryum inclinatum, Swartz.

On a peat bank above the Black Stairs on Slieve Donard, 1884: H. W. L. Very rare.

Bryum bimum, Schreb.

The Black Stairs on Slieve Donard, Anglesey Mountain, Old bog drains in Deer's Meadow: H. W. L. Rosstrevor Mountain, on a mountain south of Tollymore: Rev. C. H. Waddell. Rare.

Bryum murale, Wilson.

This was found by me in 1883, at Moira, just outside the district. Very rare.

Bryum alpinum, L.

Slieve Donard, the ivy rock in Donard Lodge Demesne, Slievenabrock, Slievenamaddy, White River Glen, Carlingford. This moss is abundant and of luxuriant growth in all these localities, but always barren: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. "Descending to near the sea level on Slieve Donard": S. A. Stewart. I verified this last record, having found this moss on rocks close to the sea margin on the base of the east slope of the mountain.

Bryum cæespititium, L.

Tievedocharragh, Fofanny, the Deer's Meadow: H. W. L. Clonallon: Rev. C. H. Waddell. Not at all common in the district.

Bryum argenteum, L.

On a wall in Donard Demesne: H. W. L. On thatch of a roof at Warrenpoint: Rev. C. H. Waddell. By no means common in the district.

Bryum capillare, L.

Very fine in Tollymore Park, with very bright red capsules on the Stone Bridge in Donard Lodge Demesne, the Black Stairs on Slieve Donard, Slievenabrock, Knockbarragh Hill, Narrowwater, Analong, the Deer's Meadow, Moygannon Glen, Fofanny: H. W. L. Common, and frequently of very luxuriant growth in the district.

Bryum capillare, *var.* majus.

In the Ballagh Park on east slope of Slieve Donard: H. W. L.

Bryum pallens, Schwartz.

Anglesey Mountain, Clermont Mountain, the Deer's Meadow, the Black Stairs on Slieve Donard: H. W. L. Rare.

Bryum ventricosum, Dicks.

(Bryum pseudotriquetrum, Hedw.)

White River Glen north of Slieve Donard, Carlingford Mountain; Anglesey Mountain, Analong, Rosstrevor Mountain, Leitrim, near Hilltown, Spinkwee River Glen, Moygannon Glen, Camlough Mountain: H. W. L. Of frequent occurrence throughout the district.

Bryum filiforme, Schpr.

The Black Stairs on Slieve Donard, Tollymore Park by side of the Shimna River, near the Waterfall in Omeath Glen: H. W. L. Rare.

MNIUM, Hedw.

Mnium undulatum, Hedw.

The Black Stairs on Slieve Donard; very fine, and approaching in size and appearance a small fern, found in crevices under loose blocks of granite on Slievenamaddy; very abundant by side of road west of Bryansford; in fine and abundant fruit under shrubs in Narrowwater Demesne; Tollymore Park: H. W. L. Rosstrevor Wood: Rev. C. H. Waddell. Common and abundant in suitable habitats throughout the range.

Mnium rostratum, Schrad.

Wall of old bridge Tollymore Park: H. W. L. Rosstrevor Wood, Moygannon Glen: Rev. C. H. Waddell. This moss is probably of more frequent occurrence, though the records of finds are so few; it has probably been overlooked for *M. punctatum*.

Mnium hornum, L.

Very abundant in extensive patches and in fine fruit in Rosstrevor Wood, Chimney Rock Mountain, Slieve Donard, Anglesey Mountain, Tollymore Park, very luxuriant at the Black Rocks on Slievenamaddy, Slieve Commedah, H. W. L. Carlingford Mountain: Rev. C. H. Waddell. Common and abundant in the district.

Mnium punctatum, Hedw.

Carlingford Mountain, the Black Stairs on Slieve Donard, Anglesey Mountain, Rosstrevor Mountain, roadside near Fofanny, the Black Rocks on Slievenamaddy, Tollymore Park, Spinkwee River Glen, the Deer's Meadow, Clermont Mountain, Rademon Woods: H. W. L. Knockbarragh Hill, Warrenpoint: Rev. C. H. Waddell.

FONTINALIS, Dill.

Fontinalis antipyretica, L.

Rosstrevor River, Tollymore Park in both the Shimna and Spinkwee Rivers, most abundant in one of the streams that constitute the head-waters of the Bann River in the Deer's Meadow: H. W. L. Frequent in some places in the district.

Fontinalis squamosa, L.

On stones in bed of river near Kilbroney: H. W. L. Very rare.

HEDWIGIA, Web.

Hedwigia albicans, Web.

(Hedwigia ciliata, Dicks.)

Slieve Donard (descending to 200 feet above sea-level), Knockbarragh Hill, Slievenamaddy, Kilbroney Bog, Spinkwee River Glen, Tievedocharragh, Clonallon at fifty feet above sea-level, Shanslieve, Carlingford Mountain, Camlough Mountain. Scarce in this latter locality: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. Frequent throughout the range.

CRYPHÆA, Hedw.

Cryphæa arborea (Huds.), Lindb.

(Cryphæa heteromalla, Hedw.)

Near Analong: H. W. L. Very rare among the mountains, but is abundant about Loughbrickland.

NECKERA, L.

Neckera crispa, L.

The Black Stairs on Slieve Donard, Tollymore Park, Golden River bank on Carlingford Mountain: H. W. L. Rare.

Neckera complanata, L.

Tollymore Park, Rocky Mountain near Hilltown, Rademon Woods: H. W. L. Not common among the mountains; but abundant in some of the woods.

HOMALIA, Schreb.

Homalia trichomanoides, Schreb.

Loughbrickland: H. W. L. Warrenpoint: Rev. C. H. Waddell. Rare.

PTERIGOPHYLLUM, Brid.

Pterigophyllum lucens, Brid.

(Hookeria lucens, Wils.)

White River Glen and the Ivy Rock on Slieve Donard, Yellow Water River between Hilltown and Kilbroney Bog, Tollymore Park: H. W. L. Narrowwater Demesne, Rosstrevor Wood: Rev. C. H. Waddell.

SPHÆROCEPHALUS, Lindb.

Sphærocephalus palustris, Lindb.

(Aulacomnion palustre, L.)

Slieve Commedah, Slievenabrock, Anglesey Mountain, the Deer's Meadow, Camlough Mountain: H. W. L. Rosstrevor Mountain, Knockbarragh Hill, Kilbroney red bog: Rev. C. H. Waddell. Occurs frequently, but is nowhere abundant.

HETEROCLADIUM, Schpr.

Heterocladium heteropterum, Schpr.

Slieve Donard, Slieve Meel Beg (1200 feet), Slievenamaddy, Windy Gap near Eagle Mountain, Spinkwee River Glen, summit of Slieve Bignian: H. W. L. Rosstrevor Mountain, Anglesey Mountain, Yellowwater River: Rev. C. H. Waddell. Frequent, but never in any abundance, throughout the range.

THUIDIUM, Neck.

Thuidium tamariscifolium, Lindb.

(Thuidium tamariscinum, Hedw.)

The Ivy rock on Slieve Donard, Tievedocharragh, Tollymore Park, Rosstrevor Wood: H. W. L. Very frequent and abundant throughout the whole district.

Thuidium recognitum, Hedw.

Anglesey Mountain, near Omeath: H. W. L. Very rare, and not hitherto recorded from Ireland. This moss is described as growing "on limestone rocks and chalk hills"; but there are neither where I got this, and the nearest lime to the spot is some five miles distant, at the Carlingford quarries. Mr. G. A. Holt decided that this is unmistakably the plant collected by me.

POROTRICHUM, Mitt.

Porotrichum alopecurum, Mitt.

(Thamnium alopecurum, L.)

Tollymore Park, Carlingford Mountain: H. W. L. Rosstrevor Mountain, Moygannon Glen: Rev. C. H. Waddell. Not common in the district.

CLIMACIUM, L.

Climacium dendroides, L.

Sandhills near Newcastle: H. W. L. Clonallon: Rev. C. H. Waddell. Rare, except at the first-mentioned locality. I found this moss on the north shore of Loughbrickland, carpeting many square yards, where the abundant fruit actually gave a ruddy tinge to the surface.

ISOTHECIUM, Brid.

Isothecium myurum, Brid.

Slieve Donard, Narrowwater Demesne, Slievenabrock, Tullyree, Tollymore Park: H. W. L. Clonallon, Anglesey Mountain: Rev. C. H. Waddell. Common.

Isothecium myurum, *var.* elongatum, Schpr.

Slievenabrock, on a wet peat bank, 1886: H. W. L. Very rare.

HOMALOTHECIUM, Schpr.

Homalothecium sericeum, L.

Rosstrevor Mountain, Spelga, Fofanny: H. W. L. Warrenpoint: Rev. C. H. Waddell. Not common in the district.

BRACHYTHECIUM, Schpr.

Brachythecium salebrosum, Hoffm.

Narrowwater Demesne, Moygannon Glen : H. W. L. Rare.

Brachythecium glareosum, B. & S.

Tollymore Park; Ferryhill near Omeath; Anglesey Mountain : H. W. L. From the few recorded localities this moss would seem to be rare, but it will probably be found to be common, and to have been overlooked owing to its resemblance to *B. rutabulum* and *Eurhynchium striatum*.

Brachythecium albicans, Neck.

Sandhills near Newcastle: H. W. L. In abundance in some spots, but not recorded elsewhere, except from Greenore, by the Rev. C. H. Waddell.

Brachythecium velutinum, L.

Banks of the Shimna river near Newcastle, the Bloodyburn Glen, on a tree near Bryansford: H. W. L. Not common, but has probably been overlooked in the district.

Brachythecium rutabulum, L.

Bloody Bridge, Tollymore Park, Brook Cottage near Newcastle, the Deer's Meadow, Slieve Donard, Clonallon; Fofanny : H. W. L. Common.

Brachythecium rivulare, B. & S.

By the River Shimna in Tollymore Park, Slieve Commedah, White River Glen on Slieve Donard, Slievenabrock, Slieve Dermot, Anglesey Mountain: H. W. L. Warrenpoint, Rosstrevor, Omeath : Rev. C. H. Waddell.

Brachythecium viride, Lam.

(Brachythecium populeum, Hedw.)

Maggie's Leap near Newcastle, Fofanny, Moygannon Glen, Donard Lodge Demesne : H. W. L. Common.

Brachythecium plumosum, Swartz.

(H. pseudoplumosum, Brid.)

Tollymore Park, the Black Stairs on Slieve Donard, Moygannon Glen, Slievenabrock, Spelga, Anglesey Mountain: H. W. L. Rosstrevor, Carrickbawn : Rev. C. H. Waddell. Slieve Croob : S. A. Stewart. Common; abundant, and fruiting freely throughout the ranges.

EURHYNCHIUM, Schpr.

Eurhynchium myosuroides, L.

Tollymore Park, the Ivy Rock in Donard Lodge Demesne, Tievedocharragh: H. W. L. Carlingford Mountain, Rosstrevor Wood: Rev. C. H. Waddell. Frequent in the district.

Eurhynchium striatum, Schreb.

Tollymore Park, Rosstrevor Wood, Slievenabrock, Anglesey Mountain: H. W. L. Bryansford, Clonallon, Narrow-water: Rev. C. H. Waddell. Frequent in the district.

Eurhynchium swartzii, Turn.

The Ivy Rock in Donard Demesne, Tollymore Park, Loughbrickland: H. W. L. Rare. This moss has, in all probability, been overlooked in the district.

Eurhynchium pumilum, Wils.

Aghaderg Glebe, near Loughbrickland: H. W. L. On the ground inside the tower of Dundrum Castle: Rev. C. H. Waddell.

Eurhynchium prælongum, Dill.

Tollymore Park, Slievenamaddy, Tullybranigan: H. W. L. Slieve Commedah, Knockbarragh Park: Rev. C. H. Waddell. "By the river in Tollymore Park": Templeton, 1805.

HYOCOMIUM, Schpr.

Hyocomium flagellare, Dicks.

The Black Stairs on Slieve Donard, Tollymore Park, Butter Mountain, Rosstrevor Wood, Slievenabrock, Anglesey Mountain, Spinkwee River Glen, Yellow River near Kilbroney Bog, Miner's Hole River Glen: H. W. L. Common throughout the range, both in very wet and dry places. Sub nomine *Hypnum umbratum*, "Tollymore Park River": J. Templeton. [This moss is not included in S. A. Stewart's N. E. Flora, doubtless an oversight.]

RHYNCOSTEGIUM, Schpr.

Rhyncostegium tenellum, Dicks.

The Black Stairs on Slieve Donard, by the side of Amy's River near the Quarry on Slieve Donard, Parnell's Bridge in Tollymore Park, wall west of Bryansford: H. W. L. Old walls of Dundrum Castle: S. A. Stewart. Rare.

Rhyncostegium confertum, Dicks.

Ashleigh near Newcastle, Tollymore Park, Knockbarragh; H. W. L. Warrenpoint: Rev. C. H. Waddell. This moss probably occurs in many places in the district.

Rhyncostegium rusciforme, Neck.

The Black Stairs on Slieve Donard, Fofanny, Rosstrevor Glen, Slieve Meel Beg, Tollymore Park: H. W. L. Not common in the district.

PLAGIOTHECIUM, Schpr.

Plagiothecium pulchellum, Hedw.

Tollymore Park: Rev. C. H. Waddell.

Plagiothecium denticulatum, L.

Chimney Rock Mountain, Cove Mountain, the Black Stairs on Slieve Donard, Slievenabrock, inside the roof of the well on the top of Slieve Donard, Slieve Meel Beg, Tollymore Park: H. W. L. Eagle Mountain: Rev. C. H. Waddell.

Plagiothecium borrerianum, Spr.

The Black Stairs and Amy's River on Slieve Donard, Slievenabrock, Cove Mountain, Tollymore Park: H. W. L. Omeath, Eagle Mountain: Rev. C. H. Waddell.

Plagiothecium sylvaticum, L.

The Black Stairs on Slieve Donard; the plant from this locality is a very beautiful form that may be considered almost a distinct variety; Slievenabrock: H. W. L. This moss is very abundant in the Cove from which the Cove Mountain takes its name, but is not common in the district. Stones in Rosstrevor Wood: S. A. Stewart.

Plagiothecium undulatum, L.

The Black Stairs on Slieve Donard, Tollymore Park, Anglesey Mountain, the Black Rocks on Slievenamaddy: H. W. L. Slieve Bignian: Rev. C. H. Waddell. Abundant in many localities throughout the range.

AMBLYSTEGIUM, Schpr.

Amblystegium serpens, L.

Narrowwater, Greenore: Rev. C. H. Waddell. This moss appears to have escaped notice except in these two localities, though it is certain to be frequent in the district.

Amblystegium riparium, L.

Slieve Commedah, summit of Slieve Martin, shores of Loughbrickland: H. W. L. Moygannon Glen, near the Rosstrevor Reservoir: Rev. C. H. Waddell. Rare.

HYPNUM, Dill.

Hypnum exannulatum, Gümb.

Glenaveagh, The Deer's Meadow, 1885: H. W. L. Clermont Cairn, Anglesey Mountain: Rev. C. H. Waddell. Rare.

Hypnum intermedium, Lind.

(= H. sendtnerii, of "London Catalogue of Mosses.")

Carlingford Mountain, 1882: Rev. C. H. Waddell.

Hypnum revolvens, Swartz.

Slieve Dermot, Anglesey Mountain, Windy Gap near Eagle Mountain, Slieve Commedah, Slieve Donard, Quarry near Carlingford, the Golden River on Carlingford Mountain, Rosstrevor Glen, Pigeon Rock Mountain, the Deer's Meadow, Camlough Mountain: H. W. L. Slieve Croob: S. A. Stewart. Frequent through the range.

Hypnum fluitans, L.

In two springs near the summit of Rosstrevor Mountain, Slieve Dermot, the Deer's Meadow—(this specimen has almost falcate leaves)—in a bog between Hilltown and Rathfriland: H. W. L. Rare.

Hypnum uncinatum, Hedw.

(H. aduncum, L.)

On stones under trees near Amy's River in Donard Lodge Demesne, on wet clayland in Tollymore Park, along the roadside to the West of Bryansford: H. W. L. Ferryhill, near Omeath: Rev. C. H. Waddell. Rare.

Hypnum filicinum, L.

The Black Stairs on Slieve Donard, the Deer's Meadow, the Quarry at Carlingford, Moygannon Glen, Slievenamaddy. The specimen from this last locality is a beautiful elongated form: H. W. L. Anglesey Mountain; Rosstrevor Mountain: Rev. C. H. Waddell. Common throughout the range.

Hypnum commutatum, Hedw.

The Black Stairs on Slieve Donard, the Deer's Meadow, Slievenabrock, Moygannon Glen, Tollymore Park, the Quarry at Carlingford: H. W. L. This last specimen was much encrusted with lime. Rosstrevor Mountain: Rev. C. H. Waddell. Not common, but abundant in some of these localities.

Hypnum falcatum, Brid.

Thomas Mountain on Slieve Donard, the Golden River on Carlingford Mountain, in a small marsh close to the sea at Analong: H. W. L. Rare.

Hypnum cupressiforme, L.

Slieve Donard, Slieve Commedah, Slieve Gullion, Shanslieve; Butter Mountain, Chimney Rock Mountain, Anglesey Mountain, the Deer's Meadow, Slieve Martin, Rocky Mountain, near Hilltown: H. W. L. Very common and plentiful in the range.

Hypnum cupressiforme, *var.* β lacunosum. Wils.

Maggie's Leap, near Newcastle, Slievenabrock, Anglesey Mountain: H. W. L. Narrowwater: Rev. C. H. Waddell. Of frequent occurrence in the district.

Hypnum cupressiforme, *var.* γ filiforme. Bry. Eur.

The Ballagh on Slieve Donard, Slievenabrock, Slieve Meel Beg, Tollymore Park, Tievedocharragh, Carlingford Mountain: H. W. L. Not common in the range.

Hypnum cupressiforme, *var.* brevisetum. Schpr.

Anglesey Mountain; Ferry Hill, near Omeath: H. W. L. Rare.

Hypnum cupressiforme, *var.* ericetorum. Bry. Eur.

(H. cupressiforme compressum, Wils.)

Ballagh Park, on Slieve Donard, Anglesey Mountain: H. W. L. Rare.

Hypnum resupinatum, Wils.

Tievedocharragh, Rocky Mountain near Hiltown, Loughbrickland: H. W. L. Moygannon Glen: Rev. C. H. Waddell. Rather rare.

Hypnum patientiæ, Lindb.

Moygannon Glen: H. W. L. Near Narrowwater, Carrickbawn, Rosstrevor Vicarage: Rev. C. H. Waddell. Rare.

Hypnum molluscum, Hedw.

The Black Rocks on Slieve Donard—(this moss grows on perpendicular rocks in this locality in robust masses, resembling *H. crista-castrensis*)—Slieve Dermot, Tollymore Park, Slievenamaddy, Slieve Commedah, Pigeon Rock Mountain, Anglesey Mountain, Carlingford Mountain: H. W. L. Rosstrevor Mountain: Rev. C. H. Waddell. Frequent throughout the range.

Hypnum palustre, L.

On rocks in stream above the Black Stairs on Slieve Donard, very abundant on schist rocks in bed of stream between Slieve Meelbeg and the Butter Mountain; Slievenabroch, the Deer's Meadow, Moygannon Glen (a dwarfed form): H. W. L. Tollymore Park: Rev. C. H. Waddell. Rather common.

Hypnum eugyrium, Schpr.

On a rock in the stream immediately above the waterfall at Omeath, 1883: Rev. C. H. Waddell. Very rare. This specimen was in fruit, and is in Mr. Waddell's herbarium. He and I spent some time on a subsequent visit in searching the identical rock on which he had found it, but failed to discover even a single stem.

Hypnum ochraceum, Turn.

Slieve Commedah, Slievenabrock, the Deer's Meadow, Omeath Glen: H. W. L. Not common except in the small streams in the Deer's Meadow, where it is very abundant and luxuriant. Tollymore Park: S. A. Stewart.

Hypnum stellatum, Schreb.

Slievenamaddy, Pigeon Rock Mountain, Slieve Donard, close to the sea at Analong, Omeath Glen, Camlough Mountain, Carlingford Mountain: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. Tollymore Park: S. A. Stewart. Not common.

Hypnum stellatum, *var.* β protensum, Brid.

Omeath waterfall, 1885: H. W. L. Very rare.

Hypnum giganteum, Schpr.

Slieve Croob: S. A. Stewart. This moss probably occurs in other places in the district, where it has been overlooked owing to its great resemblance to forms of *H. cuspidatum* and *H. cordifolium*.

Hypnum cordifolium, Hedw.

The Deer's Meadow, in a wet hollow among the sand-hills at Newcastle, in fine fruit in a bog between Hilltown and Rathfriland, H. W. L. Rare in the district.

Hypnum sarmentosum, Wahl.

Above the Black Stairs on Slieve Donard, Springwee River Glen, White River Glen, Shanslieve: H. W. L. Rare in the range.

Hypnum cuspidatum, L.

Slieve Donard, Analong close to the sea, Tollymore Park, sand-hills at Newcastle, Fofanny, Moygannon Glen, The Deer's Meadow, Slieve Commedah, Anglesey Mountain: H. W. L. Common and abundant in the district.

Hypnum schreberi, Ehrh.

(H. parietinum, L.)

The Black Stairs on Slieve Donard, Shanslieve, Springwee River Glen, Tollymore Park, Chimney Rock Mountain, Knockbarragh Hill, Bencrom, Camlough Mountain, Anglesey Mountain: H. W. L. Rosstrevor Wood: Rev. C. H. Waddell. Common throughout the range.

Hypnum purum, L.

Donard Lodge Demesne, Tollymore Park, Butter Mountain, Tievedocharragh, Anglesey Mountain, Camlough Mountain: H. W. L. Very common and abundant in the district.

Hypnum stramineum, Dicks.

Glenaveagh, the Deer's Meadow, bog between Hilltown and Rathfriland, the Brown Bog near Loughbrickland: H. W. L. Anglesey Mountain, Clermont Cairn: Rev. C. H. Waddell. Rare.

Hypnum scorpioides, L.

Rosstrevor Mountain, Slievenamaddy, Pigeon Rock Mountain, Anglesey Mountain, Camlough Mountain: H. W. L. Carlingford Mountain: Rev. C. H. Waddell; Slieve Croob: S. A. Stewart. Rather uncommon.

HYLOCOMIUM, Schpr.

Hylocomium proliferum, Hedw.

(Hylocomium splendens, Dill.)

Slieve Donard, Spinkwee River Glen, Chimney Rock Mountain, Butter Mountain, Knockbarragh Hill, Tievedocharragh, Sandhills at Newcastle: H. W. L. Rosstrevor Wood, Moygannon Glen, Anglesey Mountain: Rev. C. H. Waddell. At 2200 feet on Slieve Donard: S. A. Stewart. Very common and abundant throughout the district.

Hylocomium brevirostrum, Ehrh.

In fruit in a disused gravel pit, in Narrowwater Wood; very luxuriant and abundant in Rademon Woods: H. W. L. Moygannon Glen: Rev. C. H. Waddell. Slieve Croob: S. A. Stewart. Rare in the district.

Hylocomium squarrosum, L.

The Black Stairs on Slieve Donard, Shanslieve, Butter Mountain, Tollymore Park, Spinkwee River Glen, Anglesey Mountain, Carlingford Mountain; a beautiful yellow form in springs by the side of Yellow Water between Hilltown and Rosstrevor: H. W. L. Slieve Commedah, 2500 feet: Rev. C. H. Waddell. Common and abundant through the range from the sea-level to top of Slieve Commedah.

Hylocomium loreum, L.

Slieve Dermot, summit of Eagle Mountain, Ivy Rock and Thomas Mountain on Slieve Donard; at 100 feet above sea-level in Donard Lodge Demesne; Bencrom; very luxuriant and abundant on the black rocks on Slievenamaddy, and in many places on the east slope of Camlough Mountain: H. W. L. Rosstrevor Wood, Carlingford Mountain: Rev. C. H. Waddell. Slieve Croob: S. A. Stewart. Common throughout the range.

Hylocomium triquetrum, L.

Slieve Donard, Tollymore Park, on stones in Rosstrevor Wood, sandhills near Newcastle (a dwarfed form): H. W. L. Very common throughout the range.

HEPATICS.

FRULLANIA, Raddi.

Frullania dilatata, Dum.

Donard Demesne and Tollymore Park on trees, Tievedocharragh, and Camlough Mountain on rocks: H. W. L. Not common in the range.

Frullania fragilifolia, Tayl.

Cove Mountain on granite: H. W. L. Very rare.

Frullania tamarisci, Dum.

The Black Stairs on Slieve Donard, Slieve Meel Beg, Ballagh Park on Slieve Donard, Tollymore Park, Tievedocharragh, Knockbarragh Hill, Slievenabrock, Ivy Rock in Donard Lodge Demesne, Killeavy, Slieve Gullion, Golden River on Carlingford Mountain, Omeath Waterfall: H. W. L. Frequent.

LEJEUNEA, Mme. Libert.

Lejeunea hamatifolia. Hook.

Near the Waterfall at the Black Stairs on Slieve Donard, close to the Waterfall in Omeath Glen: H. W. L. Rare.

Lejeunea patens, Lindb.

In a bog on Carlingford Mountain: Rev. C. H. Waddell. Very rare.

Lejeunea calcarea, Lib.

Wall at the base of a bridge over the Shimna River in Tollymore Park, Omeath: Rev. C. H. Waddell. Very rare.

Lejeunea ovata, Tayl.

Slieve Donard: H. W. L. On stem of a holly at the Black Stairs on Slieve Donard: Rev. C. H. Waddell. Very rare.

Lejunea serpyllifelia, Lib.

Tollymore Park, Hen Mountain, the Black Stairs on Slieve Donard: H. W. L. Frequent, and sometimes plentiful.

Lejeunea mackaii, Hook.

Omeath Waterfall, on rocks; on old yew tree in Tollymore Park: Rev. C. H. Waddell. Very rare, not in Stewart and Corry's Flora.

RADULA, Dumortier.

Radula complanata, Dum.

Clonallon, Narrowwater Demesne, Loughbrickland: H. W. L. Rosstrevor: Rev. C. H. Waddell. Frequent, but not abundant.

Radula aquilegia, Tayl.

On wet rushes in the chasm below the Waterfall at the Black Stairs on Slieve Donard: Rev. C. H. Waddell. Very rare.

PORELLA, Dillenius.

Porella platyphylla, Dum.

On a bank at the railway embankment North of Dromore: H. W. L. This plant has doubtless been overlooked in the district.

PLEUROZIA, Dumortier.

Pleurozia purpurea, Dum.

Rocky Mountain near Hilltown, Hen Mountain: H. W. L. Very rare.

ANTHELIA, Dumortier.

Anthelia julacea, Dum.

Slieve Donard, White River Glen, Slievenabrook, Slievenamaddy, Bloodyburn Glen, the Hare's Gap, the Deer's Meadow, Shanslieve: H. W. L. I collected this plant on bare rocks, pure deep peat, and imbedded with sand by the margins of streams. Rather rare.

TRICHOLEA, Dumortier.

Tricholea tomentella, Dum.

By the Shimna River in Tollymore Park: H. W. L. Rosstrevor Mountain, Moyganon Glen: Rev. C. H. Waddell. By the Spinkwee River at the top of Tollymore Park: S. A. Stewart. Very rare.

BLEPHAROSTOMA, Dumortier.

Blepharostoma trichophylla, Dum.

Amongst sphagnum in Tollymore Park, Slievenabrock, Omeath Glen: H. W. L. Very rare.

LEPIDOZIA, Dumortier.

Lepidozia setacea, Mitt.

Amongst sphagnum, Slievenamaddy, Hen Mountain, Anglesey Mountain: H. W. L. Yellow Water River: Rev. C. H. Waddell. Rare.

Lepidozia reptans. Dum.

Rosstrevor Wood, on stones near the Waterworks, and creeping among *Dicranum scoparium:* Rev. C. H. Waddell. Very rare, and not in Stewart and Corry's Flora.

BAZZANIA, Gray.

Bazzania trilobata, B. Gr.

In dry shady nooks under stones on Thomas Mountain, on Slieve Donard: H. W. L. Very rare.

ODONTOSCHISMA, Dumortier.

Odontoschisma sphagni, Dum.

Tollymore Park; Cock Mountain: Rev. C. H. Waddell. Rare.

CEPHALOZIA, Dumortier.

Cephalozia divaricata, Sm.

Hen Mountain, bog between Hilltown and Rathfriland, lakelet near the top of Camlough Mountain: H. W. L. Very rare.

Cephalozia connivens, Dicks.

Slievenamaddy, top of Camlough Mountain: H. W. L. Very rare.

Cephalozia bicuspidata, Dum.

Slieve Donard, the Deer's Meadow, Tollymore Park, Hen Mountain, Miner's Hole River, Anglesey Mountain: H. W. L. Frequent.

Cephalozia byssacea, Dum.

Camlough Mountain among the radicles of *Bryum bimum:* H. W. L. Very rare.

SACCOGYNA, Dumortier.

Saccogyna viticulosa, Dum.

Tollymore Park, Rosstrevor Mountain, Donard Lodge Demesne, Spinkwee River Glen: H. W. L. Clermont Cairn: Rev. C. H. Waddell.

KANTIA, Gray.

Kantia trichomanis, B. Gr.

Slievenamaddy, Tollymore Park, bog between Hilltown and Rathfriland, Carlingford Mountain: H. W. L. Anglesey Mountain, Narrowwater: Rev. C. H. Waddell. Rare.

Kantia arguta, Lindb.

Slieve Donard, Hen Mountain, Warrenpoint, the Black Stairs on Slieve Donard, Slievenamaddy: H. W. L. Clonallon, by the Yellow Water River: Rev. C. H. Waddell. Frequent.

SCAPANIA, Dumortier.

Scapania undulata, Dum.

Slieve Donard (at 1700 feet), Slieve Bignian, the Deer's Meadow, Pigeon Rock Mountain, Cove Mountain, Tollymore Park, the Black Rocks on Slievenamaddy, White River Glen, Off Mountain, Slievenabrock, Omeath River Glen, Anglesey Mountain, Carlingford Mountain: H. W. L. Frequent and often abundant.

Scapania undulata, *var.* purpurascens, Nees.

Slieve Donard, Slieve Commedah, Slieve Meel Beg, Carlingford Mountain, Miner's Hole River, Yellow Water River, Windy Gap near Eagle Mountain: H. W. L. Tollymore Park: Rev. C. H. Waddell. Frequent.

Scapania nemorosa, Dum.

Thomas Mountain on Slieve Donard: H. W. L. Rosstrevor Wood, Anglesey Mountain, Tollymore Park: Rev. C. H. Waddell. Very rare.

Scapania resupinata, Dum.

Dry rock on Thomas Mountain on Slieve Donard, the Ballagh on Slieve Donard, Camlough Mountain: H. W. L. Thomas Mountain on Slieve Donard, Rosstrevor Wood, Anglesey Mountain, rocks on Eagle Mountain: Rev. C. H. Waddell. Very rare.

Scapania uliginosa, Dum.

Bog between Hilltown and Rathfriland, the Brown Bog near Loughbrickland: H. W. L. Anglesey Mountain: Rev. C. H. Waddell. Rare.

Scapania compacta, Dum.

Camlough Mountain, Slievenabrock, Anglesey Mountain, Speltha, the Deer's Meadow: H. W. L. and Rev. C. H. Waddell. Slieve Donard: J. J. Andrew. Rare, but often overlooked.

DIPLOPHYLLUM, Dumortier.

Diplophyllum albicans, Dum.

Beside the Great Cairn on the summit of Slieve Donard, Rocky Mountain, Tollymore Park, Chimney Rock Mountain, Slieve Commedah, on the Cairn on the top of Slieve Gullion, Carlingford Mountain, the Deer's Meadow, Shanslieve, Miner's Hole River: H. W. L. The most frequent and abundant hepatic in the district.

LOPHOCOLEA, Dumortier.

Lophocolea bidentata, L.

Slieve Donard, Hen Mountain, the Deer's Meadow, Miner's Hole River Glen, Tollymore Park, Anglesey Mountain, Cove Mountain, Moygannon Glen: H. W. L. Frequent.

CHILOSCYPHUS, Corda.

Chiloscyphus polyanthos, Cord.

Anglesey Mountain, Rocky Mountain near Hilltown, Rosstrevor Mountain: H. W. L. Omeath Waterfall: Rev. C. H. Waddell. Very rare.

PLAGIOCHILA, Dumortier.

Plagiochila asplenioides, Dum.

Tollymore Park, Warrenpoint, Omeath Glen, Shanslieve: H. W. L. Common in the district.

Plagiochila spinulosa, Dks.

Yellow Water River, between Rosstrevor and Hilltown: Rev. C. H. Waddell. Very rare.

MYLIA, Gray.

Mylia taylori, Hook.

The White River Glen on Slieve Donard, the Deer's Meadow, Spinkwee River Glen, Shanlieve, Omeath Glen, Anglesey Mountain, Moygannon Glen: H. W. L. Frequent.

Mylia anomala, Hook.

Camlough Mountain: H. W. L. and Rev. C. H. Waddell. Very rare.

JUNGERMANNIA, Linneus.

Jungermannia sphaerocarpa, Hook.

Pigeon Rock Mountain, Tollymore Park, Slievenamaddy, Hen Mountain, Camlough Mountain, Omeath: H. W. L. Eagle Mountain: Rev. C. H. Waddell. Rare.

Jungermannia riparia, Tayl.

Cove Mountain: H. W. L. Moygannon Glen, Tollymore Park; Rev. C. H. Waddell. Very rare.

Jungermannia quinquedentata, Huds.

Rosstrevor Mountain, Moygannon Glen, Slieve Donard: Rev. C. H. Waddell. Rare.

Jungermannia pumila, With.

Hen Mountain: Rev. C. H. Waddell.

Jungermannia porphyroleuca, N.

Clermont Mountain, Slieve Gullion: H. W. L. Carlingford, Ballyvalley, near Rosstrevor: Rev. C. H. Waddell. Very rare.

Jungermannia ventricosa, Dks.

Moygannon Glen, Slieve Martin, Slieve Gullion, Anglesey Mountain, top of Camlough Mountain: H. W. L. Slieve Commedah, Rosstrevor Wood: Rev. C. H. Waddell.

NARDIA, Gray.

Nardia crenulata, Sm.

Slieve Commedah, Golden River on Carlingford Mountain, Hen Mountain: H. W. L. Warrenpoint, Tollymore Park: Rev. C. H. Waddell. Scarce.

Nardia crenulata, *var.* gracillima, Sm.

Moygannon Glen, Tollymore Park, Golden River on Carlingford Mountain, Slieve Commedah: H. W. L. Very rare.

Nardia hyalina, Carr.

Slievenabrock, Hen Mountain, Slievenamaddy, Tollymore Park, Anglesey Mountain: H. W. L. Rare.

Nardia obovata, Carr.

Wet rocks in stream on Slieve Donard: H. W. L. Very rare.

Nardia compressa, Carr.

Wet rocks on Slieve Donard, on stones in the Blue Lake on Slieve Lamagan, Spinkwee River Glen, stream west of Slieve Meel More, Diamond Mountain: H. W. L. Eagle Mountain, in the Windy Gap: Rev. C. H. Waddell. Rare.

Nardia scalaris, B. Gr.

Tollymore Park, Shanlieve, Thomas Mountain on Slieve Donard, Slieve Commedah, Slievenabrock, Spelga, Omeath Glen: H. W. L. Frequent.

Nardia emarginata, B. Gr.

Shanlieve, Camlough Mountain, Slieve Gullion, Slieve Donard, Pigeon Rock Mountain, Cave in the Cove Mountain, the Black Rocks on Slievenamaddy, Slieve Meel Beg, Anglesey Mountain, Slieve Bearna, Chimney Rock Mountain, Tollymore Park, Miner's Hole River Glen, Spinkwee River Glen: H. W. L. Frequent.

Nardia emarginata, *var.* minor.

Among *Andreæa alpina* on Slievenabrock: H. W. L. Very rare.

CESIA, B. Gr.

Cesia crenulata, Carruth.

The Black Stairs on Slieve Donard and near the summit of this mountain, Slieve Commedah, Slievenamaddy, Hen Mountain, Pigeon Rock Mountain: H. W. L. Rare.

Cesia obtusa, Lindb.

Slieve Donard, Slieve Commedah (1800 feet), Slievenamaddy, Mountain, Hare's Gap: H. W. L.

PALLAVICINIA, Gray.

Pallavicinia hibernica, B. Gr.

In small quantity on a damp bank in the sandhills north of Newcastle Railway Station: S. A. Stewart.

BLASIA, Micheli.

Blasia pusilla, L.

Slievenamaddy, Omeath Glen, Brown Bog near Loughbrickland: H. W. L. Moygannon Glen, Anglesey Mountain, Narrow-water: Rev. C. H. Waddell. Tollymore Park: S. A. Stewart. Rare.

PELLIA, Raddi.

Pellia epiphylla, Raddi.

The Black Rocks on Slieve Donard, Moygannon Glen, Tievedo-charragh, White River Glen, Slieve Commedah, Butter Mountain, Windy Gap at foot of Eagle Mountain, Tolly-more Park, Warrenpoint: H. W. L. Very common.

Pellia calycina, Tayl.

Moygannon Glen, Tollymore Park: H. W. L. Rare.

ANEURA, Dumortier.

Aneura pinguis, B. Gr.

Slieve Donard, Ben Crom, Anglesey Mountain, Omeath Glen; H. W. L. Rosstrevor Mountain: Rev. C. H. Waddell. Common.

Aneura multifida, Gr.

The Deer's Meadow, roadside between Hilltown and Bryansford: H. W. L. Rare.

Aneura pinnatifida, Dum.

Tollymore Park: H. W. L., and Rev. C. H. Waddell. Very rare.

METZGERIA, Raddi.

Metzgeria conjugata, Lindb.

Tollymore Park, Rosstrevor Wood: Rev. C. H. Waddell.

Metzgeria furcata, Dum.

Tollymore Park, Omeath Glen: H. W. L. Common.

HEPATICA, Micheli. Lindberg.

Hepatica conica, L.

The Black Stairs on Slieve Donard, Tollymore Park, bog between Hilltown and Rathfriland, Rosstrevor Wood: H. W. L. Not common.

MARCHANTIA, Linneus.

Marchantia polymorpha, L.

Tollymore Park, the Black Stairs on Slieve Donard, Anglesey Mountain: H. W. L. Frequent, but not so common or abundant as some writers suppose.

ASTERELLA, P. Reauv.

Asterella hemisphærica, L.

Shady wall of Parnell's Bridge in Tollymore Park: H. W. L. Very rare.

RICCIA, Micheli.

Riccia fluitans, L.

Plentiful in Meenan Bog near Loughbrickland: H. W. L. Several places in the Newry Canal: S. A. Stewart.

LICHENS.

The names of the Lichens recorded in the following notes are those used in the Third Edition of Leighton's "Lichen Flora of Great Britain:" Shrewsbury, 1879.

For convenience of reference, I have arranged the few genera and species in alphabetical order.

Alectoria jubata. L.

Chimney Rock Mountain: H. W. L.

Alectoria lanata. L.

Hen Mountain, Chimney Rock Mountain: H. W. L.

Cladonia bellidiflora. Schær.

Slieve Martin: H. W L.

Cladonia cervicornis. Schær.

Slieve Commedah, Slieve Martin, Tollymore Park: H. W. L.

Cladonia cornucopioides. Fr.
Slieve Martin, Tollymore Park: H. W. L.

Cladonia digitata, *var.* macilenta. Hffm.
Shanslieve: H. W. L.

Cladonia florkeana *var.* bacillaris. Ach.
Slieve Martin: H. W. L.

Cladonia furcata. Hffm.
On the neck between Slieve Donard and Slieve Commedah, Slieve Dermot, Miner's Hole River Glen: H. W. L.

Cladonia pyxidata *var.* vera pyxidata. Fr.
Summit of Slieve Donard, Slieve Martin: H. W. L.

Cladonia rangiferina. Hffm.
Hen Mountain: H. W. L.

Cladonia squamosa. Hffm.
Top of Knockbarragh Hill near Rosstrevor, Tollymore Park: H. W. L.

Cladonia sylvatica. Hffm.
Slieve Donard: H. W. L.

Collema cheileum. Ach.
Claybank near Rosstrevor: H. W. L.

Evernia prunastri. L.
Analong, Tollymore Park: H. W. L.

Graphis elegans. Sm.
Spinkwee River Glen: H. W. L.

Graphis scripta. Ach.
On an ash tree near Newcastle: H. W. L.

Graphis scripta, f. divaricata. Leight.
Tollymore Park, Mr. Thompson, "Leighton's Lich. Fl.," p. 429.

Lecanora atra. Huds.
Maritime rocks at Analong: H. W. L.

Lecanora dicksonii. Ach.
Spinkwee River Glen: H. W. L.

Lecanora ferruginea, *var.* saxicola. Huds.
Maritime rocks at Analong, Rosstrevor Mountain: H. W. L.

Lecanora fuscata. Schrad.
Carlingford Mountain: H. W. L.

Lecanora glaucocarpa, *var.* pruinosa. Whinb.
On a bleached bone of a seabird among the sandhills near Newcastle: H. W. L.

Lecanora lacustris. With.
Carlingford Mountain; Slieve Bignian: H. W. L.

Lecanora parella. L.
On schist rocks near Maggie's Leap, Newcastle: H. W. L.

Lecanora subfusca. L.
Trees in Tollymore Park, maritime rocks at Analong: H. W. L.

Lecanora tartarea. L.
Slieve Commedah. H. W. L.

Lecanora ventosa. L.
Slieve Donard, Slievenaman, Spinkwee River Glen: H. W. L.

Lecidea aggregata. Mudd.
Maritime rocks at Analong: H. W. L.

Lecidea alboatra. Nyl.
Slieve Donard: H. W. L.

Lecidea albocærulescens. Wulf.
White River Glen, Slieve Donard: H. W. L.

Lecidea badioatra. Flk.
Anglesey Mountain: H. W. L.

Lecidea confluens. Web.
Slieve Donard, Slieve Martin, Slieve Commedah, Slievenabrock, White River Glen: H. W. L.

Lecidea contigua, Fr.
Slievenamaddy, Slieve Donard, Rosstrevor Mountain, Spinkwee River Glen, on large pebbles lying among the sandhills at Newcastle, Shanslieve, Tollymore Park: H. W. L.

Lecidea contigua f. aggregata, Mudd.

On schist stones in the wall of Tollymore Park: H. W. L.

Lecidea contigua f. flavicunda, Ach.

White River Glen, on Slieve Donard: H. W. L.

Lecidea contigua f. hydrophila, Fr.

On stones in water of the Bloody Burn on Slieve Donard: H. W. L.

Lecidea contigues f. platycarpa, Fr.

Carlingford Mountain: H. W. L.

Lecidea decolorans, Ach.

Hen Mountain: H. W. L.

Lecidea diducens, Nyl.

On large pebbles lying among the Sandhills near Newcastle: H. W. L.

Lecidea ferruginea, f. saxicola, Leight.

Rosstrevor Mountain; Maritime Rocks near Analong: H. W. L.

Lecidea geographica, L.

Slieve Donard, Slieve Bignian, Slieve Dermot, Thomas Mountain on Slieve Donard, Spinkwee River Glen: H. W. L.

Lecidea lapicida, Fr.

Thomas Mountain on Slieve Donard; Slievenamaddy; Tollymore Park: H. W. L.

Lecidea lapicida, f. ochracea, Fr.

Slieve Bignian: H. W. L.

Lecidea lavata, Fr.

Thomas Mountain on Slieve Donard; Slieve Bignian; Carlingford Mountain: H. W. L.

Lecidea lavata, f. ferrata, Nyl.

Slieve Bignian; Carlingford Mountain: H. W. L.

Lecidea limosa, Ach.

Carlingford Mountain: H. W. L.

Lecidea lithophila, Ach.
Slieve Donard, Slieve Meel Beg, Slievenabrock, Rosstrevor Mountain, Anglesey Mountain, on pebbles among the Sandhills at Newcastle: H. W. L.

Lecidea milliaria, Fr.
Hen Mountain: H. W. L.

Lecidea œderi, Web.
Slieve Donard, Slievenamaddy: H. W. L.

Lecidea petræa, Wulf.
Slieve Commedah, Rosstrevor Mountain: H. W L.

Lecidea plana, Lahm.
Wall in the "Castle" bog: H. W. L.

Lecidea platycarpa, f. hydrophila, Fr.
Thomas Mountain on Slieve Donard: H. W. L.

Lecidea polycarpa, Flk.
Tollymore Park, Shanslieve: H. W. L.

Lecidea premnea, f. saxicola, Leight.
Slievenabrock: H. W. L.

Lecidea rivulosa, Ach.
Walls of "Miner's House," on summit of Slieve Donard, Slievenamaddy, Shanslieve, Chimney Rock Mountain: H. W. L.

Lecidea squamulosa, Deak.
On large pebbles lying among the Sandhills at Newcastle: H.W.L.

Lecidea umbrina, Ach.
Maritime rocks near Analong: H. W. L.

Lichina pygmæa, Leight.
Maritime rocks, at Maggie's Leap near Newcastle: H. W. L.

Opegrapha atra, Pers.
Rosstrevor Wood: H. W. L.

Opegrapha vulgata, f. stenocarpa, Ach.
Near Newcastle: H. W. L.

Parmelia fuliginosa, f. olivacea, Leight.
On Scotch firs, the Ballagh Park on Slieve Donard: H. W. L.

Parmelia physodes, f. recurva, Leight.
On branches of larch, Tollymore Park : H. W. L.

Parmelia saxatilis, L.
Slieve Donard, Anglesey Mountain : H. W. L.

Parmelia saxatilis, f. furfuracea, Schraer.
Anglesey Mountain : H. W. L.

Parmelia saxatilis, f. omphalodes, L.
Top of Chimney Rock Mountain : H. W. L.

Peltigera canina, L.
Tollymore Park : H. W. L.

Peltigera canina, f. crispa, Whinb.
Tollymore Park : H. W. L.

Peltigera horizontalis, L.
Tollymore Park : H. W. L.

Peltigera polydactyla, Hffm.
Analong, Rosstrevor, Moygannon Glen : H. W. L.

Pertusaria communis, D. C.
Slieve Commedah, on trees in Rostrevor Wood : H. W. L.

Pertusaria communis, f. rupestris, D. C.
Maritime rocks at Maggie's Leap near Newcastle : H. W. L.

Physcia aquila, Ach.
Maritime rocks at Armar's Hole near Slieve Donard : H. W. L.

Platysma triste, Web.
Slieve Donard, Slieve Commedah.

Ramalina fraxinea, Ram.
Tollymore Park : H. W. L.

Ramalina scopulorum, Dicks.
Analong : H. W. L.

Stereocaulon condensatum, Hffm.
Top of Chimney Rock Mountain : H. W. L.

Stereocaulon coralloides, Fr.

On ruin of the "Miner's House" on the summit of Slieve Donard, Slieve Commedah, Chimney Rock Mountain: H. W. L.

Stereocaulon denudatum, Flk.

Slievenamaddy, rocks near Cloughmore, Carlingford Mountain: H. W. L.

Stereocaulon paschale, Ach.

Slieve Commedah: H. W. L.

Thelotrema lepadinum, Ach.

Rosstrevor Wood, Tollymore Park: H. W. L.

Umbilicaria cylindrica, L.

Slieve Donard: H. W. L.

Urceolaria scruposa, L.

Slieve Commedah, maritime rocks near Analong: H. W. L.

Usnea barbata, L.

On larch trees in Tollymore Park: H. W. L.

Usnea barbata, f. plicata, L.

Tollymore Park: H. W. L.

Verrucaria nigrescens, Pers.

Maritime rocks near Analong: H. W. L.

Verrucaria nitida, Weig.

Rosstrevor Wood, Tollymore Park: H. W. L.

ADDED IN PRESS.

Sphagnum acutifolium, *var.* versicolor, Warnstoff.

Slieve Donard: J. J. Andrew. New to the Irish Flora; very rare.

Sphagnum acutifolium, *var.* laetevirens, Braith.

Boggy places by streams above the Bloody Bridge on Slieve Donard: S. A. Stewart.

XXVIII.

ST. PATRICE DE ROUEN. By J. CASIMIR O'MEAGHER.

[Read November 11, 1889.]

The Parish Church of *St. Patrice* is situated in an elevated and northern part of the city of Rouen, in the centre of a quiet and pleasant quarter, and near the *Square de Solferino*, an open space in front of the new Picture Gallery. When it was built and by whom there is no record, nor is there any tradition that the Irish Apostle visited Rouen. We know that on his return from captivity he travelled from *Brotgalum* to Trajectus, which is found on an ancient map of Gaul on the River Dordogne, about 60 miles to the east of *Burdigala*, the modern Bordeaux.

In 1228, on the feast of St. Lawrence, the Church of *St. Patrice* was burned. In 1374 the Archbishop Phillipe d'Alençon founded in *St. Patrice* the Confraternity of the Passion. On every Holy Thursday the Confraternity, recruited from the ranks of the most respectable citizens, assembled in the church and formed a solemn procession, which was preceded by a band of children carrying the implements of the Passion, and followed by twelve poor men clothed at the expense of the Confraternity. After service and sermon, three of the principal members of the Confraternity washed the feet of the poor men, and subsequently entertained them—whilst each child that took part in the procession received five sous, a small loaf, and a herring.

In 1442 the Confraternity performed a Passion Play in the *Cimitière des Jacobins*, and in 1498 a Passion Play was acted in the church.

In 1535 the church was rebuilt on the original site, but on a larger scale. A Literary Society was founded in *St. Patrice* in 1543, with the object of encouraging the composition of verses and sonnets in commemoration of the death of Christ. Again, in 1592, the church was in the hands of the reconstructor, and in 1683 it was greatly damaged by a terrific storm.

The church is a very interesting edifice to visit, although it offers but a poor idea of late decorated Gothic architecture; considering it in its entirety, it is a very regular building, but of mediocre proportions.

It has neither choir nor transepts. The tower is romanesque, surmounted by a carillon. There are but two entrances to it—one in *Rue St. Patrice*, now blocked up, and the other in *Rue Neuve St. Patrice.* Over this entrance are two spirited groups, carved in Caen stone; the upper group represents Logaire mac Noill's druid attempting to poison the Apostle, and the lower, the baptism of *Oengus mac Natfraich.* The Apostle is represented in cope and jewelled mitre, the soldiers in Norman armour, and the laity in the costume of that period. The vaulted roof is supported by two rows of pillars, which divide the church into nave and aisles. The high altar, which is covered by a valdacchino, stands in a shallow apex at the eastern end of the nave, on either side of which are two altars—one dedicated to the B. V. M. and the other to St. Joseph. The beautiful sculptured woodwork which embellishes these altars came from the suppressed Church of *St. Eloi.* A peculiarity in *St. Patrice* is, that it has no Communion-rail, and that a portion of the nave has been railed off and fitted with *sedilia.* The pulpit, which is erected on the Gospel side of the altar, is not devoid of artistic merit; it was brought from the ruined Church of St. Lo; and the organ, which passed in the sixteenth century as one of the first in France, is encased in richly-carved oak.

Upon entering *St. Patrice* the visitor's attention is at once drawn to the rare painted-glass windows, dating from the sixteenth century, the period at which painting on glass was in full perfection.

The window dedicated to St. Patrick is immediately behind the pulpit. The upper panels illustrate three of his miracles, thus described in the Tripartite Life, edited by Whitley Stokes:—

> "Now, when the holy Patrick was born, he was taken to the blind, flat-faced son to be baptised. Gornias was the priest's name, and there was no water by him wherewith he could perform the baptism: so with the infant's hand he made the sign of the Cross over the earth, and a well of water broke thereout. Gornias washed his face (with that water) and his eyes were opened, and he read the (order of) Baptism: he who had never learned letters."—Page 9.

And

> "At another time, as Patrick was playing among his foster-brothers in the season of winter and cold especially, he gathered his lapful of icicles, and carried them home to his foster-mother. Then said his foster-mother to him: 'To bring a faggot of firewood, that we might warm ourselves thereat, were better for

us than what thou hast brought.' Then he said to his foster-mother: 'Believe that it is competent to God that even icicles should flame like firewood;' and, quicker than speech, when the icicles were set on fire, and when he breathed under it, they flamed forthwith like firewood, and God's name and Patrick's were magnified by that miracle."—Page 11.

Underneath is an incomplete inscription in black letter:—

"...... baptesme sort une fontaine
...... veux des glaçons ur ......"

At the top of the window the saint is represented as a young lad carried off into slavery, and underneath the panel is an inscription:—

"Ceulx d'Ibernie font un effort contre
la Bretagne ou S Patrix est pris prison."

To the right and beneath the above is a panel illustrating:—

"When Patrick was biding in the wilderness, he heard the voice of the angel saying to him: 'Ready is the ship whereon thou mayest fare to Italy to learn the Scriptures.' Said Patrick: 'I have not the price (of my ransom) in gold for my lord, and without that he will not allow me (to leave him).' The angel said to him: 'Mind thou the herd to-day, and thou wilt see a boar uprooting the earth, and he will bring a mass of gold thereout, and give thou (that gold) to thy lord for thy head, and fare forth from this land to learn wisdom and godliness.' Patrick watched the boar, and found the mass of gold, and gave it for his head to his lord, who consented to let him go, for he was glad of the gold."—The *Lebar Brecc*, Homily on St. Patrick. W.S., p. 443.

And underneath is an inscription, of which the following words alone remain:—

"...... garder les pourceaulx fange.
...... trésor fouillé par iceulx."

Beneath this panel is a representation of St. Patrick's visit to Sescnen, the father of Benignus:—

"(He sailed) along the sea to Magh Breg (and stopped at Inver Colptha),[1] and he found there great welcome in that place from

[1] The mouth of the Boyne.

a certain Franklin who both believed in him with all his household and was baptized, wherefore with him he (Patrick) left his boat. A little boy that was biding in the house gave love to Patrick, and took hold of his leg as he was going into the chariot, and his family surrendered him to Patrick, and Patrick takes him with him, and this is Benen, Patrick's gillie."—The *Lebar Brecc*, Homily on St. Patrick, W.S., 455.

Underneath is the inscription:—

"Retournant de . . . . . . son hoste le
fils duquel convertit."

The pedigree of Benignus is thus given among the saints' pedigrees in the *Book of Lecan*:—

"Benen, son of Sescnen, psalmist to St. Patrick, of the Cianachta of Glenn Gemhin, of the race of Tadhg, son of Cian, son of Oilill Ollum."

Lower down in the centre is a representation of the attempt of the Druid Lucat-Moel to poison the saint:—

"Patrick is then called to the king's couch that he might eat food. Howbeit Patrick refused not that. The wizard Lucat-Moel put a drop of poison into Patrick's cruse, and gave it into Patrick's hand. But Patrick blessed the cruse and inverted the vessel and the poison fell thereout, and not even a little of the ale fell, and Patrick afterwards drank the ale."—The *Lebar Brecc*. Homily on St. Patrick, W.S., p. 450.

Then follows an illustration of another miracle:—

"Then three of the Ui Meith Mendait Tire stole (and ate) one of the two goats that used to carry water for Patrick, and came to swear a lie. It bleated from the bellies of the three. 'My God's doom,' said Patrick, 'the goat himself hides not the stead wherein he is.'"—The *Lebar Brecc*, Homily on St. Patrick, W.S., p. 467.

The inscription beneath is:—

"Le venim ne luy peult nuire et fait qu'un laron
Beele ainsi que la brevis qu'el avoit dérobée."

To the left of the preceding is depicted Locgair's druid, Lucat-mael, challenging the saint to work miracles:—

"Thereafter the hosts fared forth out of Tara. Then said the wizard: 'Let us work miracles together that we may know which of us is the stronger.' 'So be it done,' said Patrick. Then the wizard brought snow over the plain till it reached men's shoulders. *Dixit Patricius* to him: 'Put it away if thou canst.' *Dixit magnus:* 'I cannot till the same time to-morrow.' 'By my *debroth*' (that is, by my God of judgment),' saith Patrick, 'it is in evil thy power lieth, and nowise in good.' Patrick blessed the plain, and the snow melted at once.

"The wizard invoked demons, and over the plain he brought darkness that could be felt, and trembling and terror seized every one. *Dixit Patricius:* 'Take away the darkness if thou canst.' The wizard replied: 'I cannot till the same time to-morrow.' Patrick blessed the plain, and the darkness at once departed, and the sun shone forth. . . . All who were there gave thanks to God and to Patrick."—*Lebar Brecc*, Homily on St. Patrick, W.S., p. 461.

The inscription beneath is:—

"Le temps nebuleux et la terre couverte de
Nèges et en un instant descouverte et la terre fertille."

To the right of the above is given the baptism of King Oengus mac Natfraich:—

"Patrick passed afterwards by Belach Gabrain into the province of Munster, and preached to the territories and to the churches, so that they believed and were baptised and he blessed them, and with them he left priests instructing (them) and practising godliness. When he reached Maghfemin, he was received by Oengus, son of Natfraich, King of Munster. Oengus made him great welcome, and brought him to his house to Cashel. Patrick preached to him. The hinder end of his crozier went through his foot and wounded it greatly. Patrick said: 'Why didst thou not protect thyself?' 'Methought,' saith Oengus, 'that it was a rite of religion.' Said Patrick: 'Blood shall not be shed in this place from to-day to doom; and of all those that shall succeed thee but one king shall be slain.'"—*Lebar Brecc*, Homily on St. Patrick, W.S., p. 470.

The inscription beneath is:—

> "Mict son baston pastoral pour pra . . . er
> . . . et le pied d'un capitaine et le . . . rist."

In the centre of the window St. Patrick's figure is of larger proportions than in any other panel. He is depicted in cope[1] and mitre,[2] and wearing on his shoulders the pallium, received, according to the Bollandists, from Leo the Great in 444, and carrying in his right hand an Archbishop's crozier. In front of the prelate are a number of venomous reptiles which he is driving before him, and from above the Almighty is represented blessing his mission. Below is an incomplete inscription:—

> "Il chassa (d'Ib)ernie les
> . . . bestes."

I failed to find any confirmation of St. Patrick having been invested with the pallium. The *Annals of Ulster* under the year 441 merely record: "Leo being ordained the 41st bishop of the Roman Church, the faith of Patrick the bishop was approved." Lastly, to the left is portrayed the saint's fast, and his descent from Croagh Patrick:—

> "Thereafter Patrick gat him into the wilderness, that is, to Cruachan Aigli, after the mayner of Moses, and Elias, and Christ. And for forty days and forty nights he fasted in that place, having four stones about him and a stone under him, even as Moses fasted on Mount Sinai when the Law was delivered unto him. For they, Moses and Patrick, were alike in many ways. One hundred and twenty years was the age of them both. Each was a leader of people. Forty nights on mountains they fasted, and the burial places of them both are uncertain."—*Lebar Breco*, Homily on St. Patrick, W.S., p. 475.

And his descent from Croagh Patrick, when he is met by a crowd, and in order to emphasise his preachings by a miracle, he struck the ground with his pastoral staff, and thereupon a deep chasm was formed, which is represented on the window as filled with flames. The inscription is:—

> "Luy priant la terre s'ouvre que l'on
> Appelle le purgatoire Sainct Patrice.

[1] *Cope.*—*The Tripartite Life* and the *Book of Armagh* only mention white robes as being worn by St. Patrick and his clerics. Coloured vestments were first sanctioned by Pope Innocent III., 1198–1208.

[2] *Mitre.*—The present shape of the mitre was assumed about the thirteenth century; at first it was low, with the sides straight, and afterwards its height was increased, and eventually it assumed its present swelling and rounded form.

There are other fine windows in this church, depicting—The Torments of Job (9); Three Episodes in the Life of Abraham; The Salutation; The Visitation; The Annunciation; The Adoration; The Virgin and Child; The Infant Saviour bearing in His hand the Terrestrial Globe; St. John; St. James; The Woman Accused of Adultery. Three windows contain the insignia of the Passion; another portrays Mater Dolorosa; and the three windows over the high altar represent the Passion, Death, and Resurrection. The Golden Legend of St. Eustach, and the Life of St. Louis are also depicted; and a window, presented in the year 1540 by the Confraternity of St. Fiacre is still intact. These windows suffered more or less from the storm which burst over Rouen in 1683. They were repaired in 1683, 1726, 1727, and 1765 by the Le Viel family, one of whom wrote *l'Art de la Peinture sur verre.*

In 1839 the Government, Louis Philippe being then on the throne, at the request of the Prefect Baron Dupont-Delporte, erected a handsome stained-glass window in this church, illustrating the four principal events in the life of St. John the Baptist.

St. Patrice is also adorned by several fine pictures.—The Apostles Leaving the Temple; a St. Justine, respectively attributed to Poussin and Mignard; a Crucifixion, by Bassano; and a St. Michael, by Hyacinth Langlois.

I am indebted to Canon Cayez, the venerable Curé of *St. Patrice,* for his deciphering the black-letter inscriptions on the window dedicated to our National Saint, and for photographs of the interior and exterior of his church.

XXIX.

NOTES ON THE HISTORY OF THE IRISH WOLF-DOG.

BY PROFESSOR J. P. O'REILLY.

[Read JANUARY 13, 1890.]

So much has been written in relation to the Irish wolf-dog, as well from the historical as from the zoological point of view, that it would seem difficult to bring forward any new matter directly bearing on this question, unless fresh sources of information be drawn on, or that those already in existence be made to yield new or additional data on points which still remain obscure or unexplored. The notes which I venture to submit to the Academy relative to the matter are more properly of the latter class, being simply the outcome of the reading of a work now more than 114 years old, but not much known in this country, nor, at first sight, likely to furnish any data whatsoever in connexion with this interesting subject. I refer to the work of Don Guillermo Bowles, "Introduccion á la Historia Natural, y á Geografia fisica de España." The first edition was published in Madrid in the year 1775, and the third edition, from which the present notes are taken, appeared there in 1789. As a prologue to this are given three letters from Don Joseph Nicholas de Azara, relative to the manner in which the work had been received at home and abroad, and had been drawn upon by writers of travels in Spain. In the third of these letters, is fortunately given a short biography of the author, which, containing seemingly all that was known about him, and being very short, may, without disadvantage, be transcribed here, not only because of its historic interest, but also in order to afford a standard by which to appreciate his statements, since the value of the author's observations must be measured by the amount of scientific knowledge he possessed, as also by his experience and training as an observer of natural phenomena.

"ROME, *7th November*, 1782.

"Bowles' book, the second edition of which, it seems, is now nearly exhausted, has met with a favourable reception in Spain, as also abroad; and as there are naturally many readers desirous of learning who this traveller was, who so seldom speaks of himself, and never of things of which he had not a knowledge, nor of adventures

which he may have met with on the highways or in roadside inns, it has appeared to me that they would be pleased should I detail the little that I know of him.

"Don Guillermo Bowles was born in a village in the neighbourhood of the city of Cork in Ireland (about 1714). After having pursued the course of studies usual for youths of his time, his parents decided that he should follow the legal profession. This he did for some time, not without great repugnance. Finally, however, he determined on going to Paris in 1740, where, following the bent of his mind, he applied himself to the study of the natural sciences, chemistry, metallurgy, and anatomy. He subsequently visited nearly all the provinces of France, making observations on their mines, their vegetable, and other productions. The journals of these travels are in my possession, and would furnish the material of a work equally interesting as that on Spain.

"Being in Paris in 1752, he there chanced to make the acquaintance of Don Antonio de Ulloa, Knight Commander of Ocaña in the Order of Santiago, and at present lieutenant-general of the royal navy, who proposed to him that he should take service in Spain. He accepted the offer which was made through Ulloa, with the intention of occupying himself in visiting the mines, and in establishing and directing a museum of natural history, as also a chemical laboratory.

"His first commission was to visit and repair the works of the Almaden mine, which had been stopped in consequence of the damage caused by a fire therein. He subsequently visited the southern provinces, collecting specimens for the museum, and was occupied with researches on and analyses of the various ores submitted to him of those brought from New Spain and Peru. During four years he served the king without pay, not liking to bind himself by accepting any, until he had seen whether the climate agreed with him or not. When, having come to a decision, he was asked by the Ministers Don Ricardo Wall and the Count de Valdeparaiso what salary he would accept, he answered that 24,000 reals (about £240) would be enough, thus astonishing these Ministers by his disinterestedness and moderation.

"He was tall and of fine appearance, generous, honourable, gay, and frank, and a lover of good society. These qualities brought him into relation with, and secured for him the appreciation of, a great number of persons distinguished by their high birth, their ministerial connexions, and their literary standing.

"He usually resided in Madrid or in Bilbao, where he was at four

different periods, preferring its climate on account of the mildness of the air and of the singular amenity of the place. He finally settled in Madrid, where he died the 25th of August, 1780, in the 66th year of his age or thereabouts. He was buried in the parish of St. Martin, and his portrait, the property of his widow, will be placed in the Museum of Natural History."

It may be gathered from this short notice that Bowles was fitted for scientific work by his studies and travels, and that corresponding weight may consequently be attached to his statements. In his chapter "On Biscay in General" (De Vizcaya en Genéral), speaking of the animals of chase, he says:—

"I saw no wild rabbits (no small luck for the country), nor stags, fallow deer, or roebucks (ciervos, gamos, ni corzos). In the woods may be met with by chance a wild boar (javali). Don Manuel de las Casas, who was Minister of Marine at San Sebastian, killed, in his native place, Las Encartaciones, a very large ounce or lynx (lobo cerval). The ordinary wolves (lobos comunes) are rare, either because there are but few small cattle, or because—the whole country being covered with farms (caserías)—should one be seen, he is at once hunted and killed, *for which work are excellent the greyhound dogs* (perros lebreles) *which they have brought here from Ireland* (para lo qual, son excellentes los perros lebreles, que hay alli trahidos de Irlanda.)' From century to century is seen a bear, an animal common in the mountains of Leon and Asturias," &c.

In Mr. Dillon's work, *Travels in Spain* (1782): Letter XVI.—Description of the Lordship of Biscay and its Products—which is really a free translation of Bowles' chapter "De Vizcaya en Genéral," he says, p. 160:—"In the plains they have hares, but no rabbits, nor any deer, nor roebucks, which last the Spaniards call *corzo*, as coming originally from Corsica, as they give the name of galgo to a greyhound, having first had them from Gaul; as Martial says:—'Leporemque cæsum Gallici canis dente,' Lib. III., Epig. 47. The woods are not without wild bears; and Don Manuel de las Casas, who had been Minister of Marine at St. Sebastian's, killed a very large lynx (*lupus cervarius*), in that part called 'las Ecartaciones'; but the common wolf is scarce, there being so few sheep to entice them, and the country so fully inhabited, by which means they are immediately discovered and killed," &c.

Nothing can be more precise than the terms used by Bowles; and

it would appear from this that it was then customary to import from Ireland wolf-dogs for the hunting of the wolves in this part of the Pyrenees.

Examining now the word *lebrel* as to its precise signification, the following remarks may not be without interest. The word is so closely related to *liebre*, = French *lièvre*, that there would, at first, seem to be apparently no doubt as to its signifying the dog with which hares are hunted, that is, a greyhound; and if the more modern dictionaries be alone consulted, such will be found given as the meaning of the word.

Thus Blanc's Dictionary, Spanish and French (1849), gives for *lebrel* = *levrier*, which, in Spier's Dictionary, is rendered greyhound, harrier, harehound.

Newman's Dictionary, Spanish and English (1809), gives for *lebrel* "greyhound" = *Canis variegatus.*

The Dictionary of the Royal Academy of Spain (1832) gives for the words already referred to the following significations:—

Lebrel.—Perro cuyo cuerpo es delgado y enxuto (thin and lean) Su cabaza y piernas largas; sus ojos grandes; es muy lijero, y sirve para la caza major; como venados, jabalies, osos, &c., = *canis leporarius.* "A dog whose body is thin and lean; his head and legs long; his eyes large; is very light of foot, and is used in hunting the larger game, such as venison and wild boars, &c., = *canis leporarius.*"

For *galgo* it gives:—"Perro de suma lijereza," "a dog very light of foot" = *canis gallicus.*

Two proverbs are cited, amongst others:—"A la larga el galgo, á la liébre mata. En enero ni galgo lebrero, ni halcon perdiguero."

For *mastin* it gives:—"Perro grande y fornido (a dog big and well-built or powerful) = *canis pecuarius*, sirve regularmente para guardar el ganado."

Going back, however, to earlier authors, we find H^{io}. San Jozé Geral Delpino (1763), Pinedos (1740), and Stevens (London, 1724), all three giving for *lebrel*, "*An Irish greyhound, though some will use it for a common greyhound, which is not proper, these being called galgos*"; while the remarkable (Spanish and Italian) Dictionary of Lorenzo Franciosini Fiorentino (Venice, 1645) gives for *lebrel* = "cane da porci, comme quelli che vengon di Francia o d'Inghelterra" (a swineherd dog, such as those which come from France or England).

The Spanish-English Dictionary of Richard Percival (London,

1623) gives for *lebrel* a harrier, a greyhound; and for *galgo*, a greyhound.

On the other hand, few of these dictionaries give, in their English-Spanish part, a rendering for wolf-dog.

Lopez and Bensley give for wolf-dog:—"Perro de pastor; especie de mastin dotado de mucha aptitud para guardar los rebaños" (a shepherd's dog, a sort of mastiff, endowed with much aptitude for guarding flocks).

Pinedos gives for wolf-dog, *lobero*, which can hardly be correct, since the word simply means pertaining to wolves.

Neumann gives for wolf-dog *mastin*.

If now the Portuguese dictionaries be consulted, we should expect to meet with the older forms and significations, since the Portuguese became detached from the other Latin languages about the 13th century.

In Lacerda's Dictionary (1871, Lisbon) there is given for *lebre* = *lebreo* (mastiff-dog, greyhound); for the English word wolf-dog he gives:—"Rafeiro; mastim; cão de gado; cão mestico ou gerado do cão e da loba." This last explanation is interesting, as pointing to the mastiff being a cross between the dog and the wolf.

The different renderings mentioned do not give a very precise signification for the word *lebrel*, a certain confusion seeming to exist as regards the meanings of the words *lebrel* and *galgo*. That *galgo* is essentially the greyhound seems clear, both from the general agreement as to this sense for the word, as also from the connexion which is established between *galgo* and *liebre* in the different proverbs cited. Stevens and Pinedos both give the proverb, "*A galgo viejo, echale liebre, no conejo*"; with the translation, "Slip an old greyhound after a hare, not after a rabbit." Stevens does not say that the Irish greyhound, termed *lebrel* in Spanish, was used for hunting the wolf; but that would result directly from the statement by Bowles already quoted, as also by implication from the explanation given for the word by the Dictionary of the Royal Spanish Academy, as to its being specially used for the larger game.

The explanation given by the Venetian Dictionary of Fiorentino, "a swineherd dog, or dog for swine such as come from France and England," does not contradict Stevens' explanation, and would be in agreement with that of the Royal Spanish Academy, since a dog which would be used for herding swine in forest districts, where acorns are abundant—that is, a mountainous district such as the Pyrenees—should be able to cope with wolves; he should therefore

be big and strong and courageous, and able for any of the larger game. The interesting part of this explanation is that pointing to the French or English origin of the dogs known as *lebreles*, which not merely confirms Stevens, but also supports Bowles, and furthermore shows that the fact must have been notorious of the bringing of these dogs from abroad into Spain during the 17th and 18th centuries, and it may be supposed, during the 16th.

In the remarkable work, *L'Origine du Français*, vol. ii., p. 292 (by the Abbé J. Espagnolle, Paris, 1888), he gives the following details as to the word—"Loup-garou, = *vere-wolf*, Anglo-Saxon; *λύγκούριον* = urine du lynx. Le mot *λυγκούριον* a été prononçé diversement suivant les pays; on en a fait *leu-warou; loup-berrou; loup-brou; warou; garou; loucarou;* comme loup se prononçait *leu* dans notre vieille langue, il y a eu confusion entre *leu* = loup, et la première syllabe de *λυγκούριον*, *λυγξ*, car en réalité le *lupus* latin n'a rien à voir dans le *loup garou* bien que nom y soit. Le loup-cervier est encore le *λυγκούριον* grec ou plutôt le *λυγκάριον* éolian, avec le digamma *λυκαρ-Ϝιον*." Comparing the form *loup-brou*, = *leu-brou*, with the Portuguese *lebreo*, = *lebre*, = Spanish *lebrel*, it may be taken that the word *lebrel* really meant originally a lynx or *loup-cervier*. Hence the *perro lebrel* mentioned by Bowles would really mean a wolf-dog.

The conclusion may therefore be drawn that during the centuries mentioned dogs were imported from France, England, or Ireland for either hunting the wolf or for protecting herds of swine when out feeding on acorns in forest districts where wolves abound, such as the Pyrenees.

The seeming confusion in the renderings of the words *lebrel* and *galgo* may have arisen from the circumstance of two classes of dogs being used against the wolf, both necessarily large, strong, and courageous. The *one* used by sportsmen for *hunting* that animal, the Irish wolf-dog, being known in Spain by the term *lebrel*, probably by reason of his lithe form and likeness in shape to the greyhound proper. The *other*, a herd's or shepherd's dog, which, according to Fiorentino, was the *lebrel;* but he also gives for *mastin*, a shepherd's dog; so that, in this respect *lebrel* = *mastin*. Now, Neumann gives for wolf-dog *mastin*, which is also old French for *mâtin* = mastiff, the Irish for which is *maistin*, and Portuguese *mastim*, also explained as *lebre*, = wolf-dog. Thus it would appear that the *mastin* = mastiff, was used as the shepherd's dog in protecting his herds against the wolf on the Continent. It is worth citing that, in the *Dictionnaire Universel de M. Boiste* (1823), *mâtin* is explained, *gros chien; molossus*. The term

molosse being explained by Littré:—"Espèce de chien que les anciens employaient à la garde des troupeaux," and being still in use in French poetry.

Taking for granted that there was an importation of Irish wolf-dogs in Spain during the 17th and commencement of 18th centuries, it would be reasonable to presume that the race of these dogs may still be surviving in Biscay or other parts of the Pyrenees, since wolves exist there still, swine are herded as of yore, and the climate of this mountainy district would not materially tend to the degeneration of the race.

There is a further question as regards the importation—that is, how far back historically can it be traced? and whether directly from Ireland or through foreign ports? In the solving of this question some light might perhaps be thrown on the obscure traditions concerning the relations of Ireland with Spain in olden times.

XXX.

ON THE STABILITY AND SMALL OSCILLATION OF A PERFECT LIQUID FULL OF NEARLY STRAIGHT CORELESS VORTICES. By SIR W. THOMSON, F.R.S., Hon. Mem. R.I.A. (Plate XIX.)

(Extract from a Letter to Professor Fitz Gerald.)

[Read November 30, 1889.]

"I have quite confirmed one thing I was going to write to you (in continuation with my letter of October 26) viz. that rotational vortex cores must be absolutely discarded, and we must have nothing but irrotational revolution and vacuous cores. So not to speak of my little piece of coreless vortex work ('Vibrations of a Columnar Vortex,' *Proc.*, R.S.E., March 1, 1880), Hick's Paper, 'On the Steady Motion and small Vibrations of a Hollow Vortex' *Transactions*, Roy. Society, 1884), will be the beginning of the Vortex Theory of ether and matter, if it is ever to be a theory. Steady motion, with crossing lines of vortex column, is impossible with rotational cores, but is possible with vacuous cores and purely irrotational circulations around them. The accompanying diagram (Fig. 1, Pl. xix.) helps to explain by an illustration. It shows the shape of an infinitely long cylindrical vacuous vortex column as disturbed by a rigid tore,[1] held fixed in a plane perpendicular to the axis of the column, and having irrotational circulation through itself. Blue represents vacuum; the white on each side, liquid; and the two black circles section of the tore. The curves representing the boundary of the vortex are calculated to give uniform resultant fluid velocity over the whole surface of the hollow core. This velocity is the resultant of the velocities due to the circulation around the vacuous core, and to circulation through the tore. The former is rigorously in inverse proportion to distance from the axis of the vacuous column. The latter is approximately parallel to this axis, and in inverse proportion to

[1] Or circular ring of circular cross section, like an anchor ring.

the cube of the distance from the circular axis of the tore. The equation of the curve is easily written down. It is calculated for the case in which the velocity at the centre of the tore (were there no vacuity) due to circulation through the tore, is equal to $\sqrt{8}/3$ of the velocity at the boundary of the vacuous column at great enough distances on either side to be undisturbed by the circulation through the tore. This makes the maximum diameter of the vacuous core three times the undisturbed diameter. If the velocity-component, due to the disturbance, is small in comparison with the surface-velocity of the vortex column, the swelling will, of course, be but a small fraction of the radius of the undisturbed column. Try to get a corresponding problem of steady motion *with rotational core*, and you will see why I now abjure rotational motion, and definitively adopt vacuum for all cores.

"Now, consider a uniform distribution throughout space, of vacuous vortex columns; represented by section perpendicular to the length in Fig. 2, Pl. xix.; red and blue, each representing vacuum, but with opposite circulations around them. But, instead of the proportions of the diagram, let the distance from each column to its three nearest neighbours be enormously great in comparison with the diameters of the columns. I think I can now prove that this arrangement of vortices is stable; but its quasi-rigidity relatively to two-dimensional motion, without change of volume of the cores, is exceedingly small, and the corresponding laminar wave-motion exceedingly sluggish in comparison with the tensile quasi-rigidity, and corresponding wave-velocity which we should find by considering laminar motion in planes parallel to the plane of the diagram.

Now, imagine a very great number of planes in all directions—as many within an angle of 1° of any one plane, as within 1° degree of any other. And let there be a distribution of straight vortex vacuous cores (as represented in Fig. 2), perpendicular to every one of these planes. The cores being thin enough, they may be placed along straight lines, no one of which intersects any other. The mutual influence of the vortices will produce disturbances from the straight lines in which we supposed them given, and slight swellings and deviations from exactly circular figure, in their cross sections; and there will be sluggish motions of the cores, unless they are all placed so as to fulfil a definite condition giving steady motion. Even if this definite condition is not exactly fulfilled, the tensile quasi-rigidity, and corresponding velocity of laminar waves of the medium, thus kinetically constituted, will certainly differ but little from what they

would be if the vortices were arranged so as to give absolutely steady motion for the equilibrium condition of the medium.

"I have been anxiously considering the effect of free vortex rings with vacuous cores among the vortex columns of this tensile vortex ether, as suggested for cored vortices at the end of your communication of April 26, 1889, to *Nature*. It will be an exceedingly interesting dynamical question; though it seems to promise at present but little towards explaining universal gravitation or any other property of matter; so you may imagine I do not see much hope for chemistry and electro-magnetism."

XXXI.

REPORT ON THE BOTANY OF SOUTH CLARE AND THE SHANNON. By S. A. STEWART, Fellow of the Botanical Society of Edinburgh, Curator of the Collections in the Museum of the Belfast Natural History and Philosophical Society.

[Read May 27, 1889.]

The district with which this Report is concerned is very irregularly limited, and its bounds cannot be defined with much exactness. It ranges in latitude from 52° 25′ N., at the southern side of the Shannon's mouth, to 52° 51′ at Ennis. Its longitudinal extremes are, Limerick, 8° 38′ W., and Kerry Head, 9° 50′. Portions of three counties—Clare, Limerick, and Kerry—are embraced in this area, which is mainly interesting by reason of its including the wide and deep estuary of the greatest of British rivers. Ennis in the east, and Kilrush in the west, were the principal centres of observation in South Clare. Most attention was paid to Clare, and a wider area was examined in this county than in either Limerick or Kerry. From Ennis the lower Fergus flows, with a slow, deep current, through low-lying flats formed of alluvial deposits. This river opens into the Shannon through a wide estuary of its own, some fifteen miles below Limerick, and about twelve miles south of Ennis, and is tidal almost as far up as the latter place. The surface of the country, in this part of the county, is flat and uninteresting, with numerous small bogs and lakes lying amongst low hills. The lakelets are in many cases surrounded by planting, and they form the one attractive feature in the landscape. The margins of the Fergus are so marshy as to be almost inaccessible to the pedestrian naturalist; its vicinity will probably yield some interesting fenland plants when more fully examined. Kilrush is seated on the northern bank of the Shannon a considerable distance above its mouth. The north side of the estuary is here separated from the Atlantic by a long, narrow peninsula, which terminates at Loop Head about twenty miles below Kilrush. Inland the scene rises gradually from both sides, and much of the median portion of the peninsula consists of extensive, elevated peat

bogs. Rocky shores, interspersed with frequent sand dunes, characterize the exterior coast, while on the side of the estuary shingly and muddy beaches prevail. The country on the south of the estuary is made of interest by the many, and sometimes extensive, woods that diversify the scenery. At Ringmoylan Point, some ten miles below Limerick, there are remains of what seems to have been a rather extensive natural forest, but the trees now standing are mostly dead. Curragh Chase is an extensive wood which, if it were to be well searched, would occupy a botanist for many days. The wood-covered rocks at Foynes are also most interesting to the naturalist. On the Kerry coast, further west, the shores are rocky, with occasional sandy beaches, which gave good results as regards maritime plants. Ballybunion, a seaside resort with considerable natural attractions, has a wide stretch of sandhills that extend some two miles to the south, and yield a good number of scarce plants. It is not to be supposed that the six days spent by me at this place in the summers of 1885 and 1886, by any means exhausted its botanical interest.

The leading feature, as respects the geology of the neighbourhood of the Shannon Estuary, is the prevalence of rocks of one great geological epoch, namely, the Carboniferous; rocks which though brought comparatively near together, as regards age, are yet very unlike in structural and in chemical characters, producing, therefore, very different effects on the aspect of the country, and on its vegetable productions. The shales of the Coal Measures form the dominant rocks of the greater part of the district. Commercially they yield, in places, flag-stones of marketable value, and thin seams of coal occur. In the district west of Foynes the coals lie at but slight depths below the surface, and from time to time have been worked in a primitive and inexpensive manner. Frequently the older rocks are obscured by alluvial deposits, the courses of the more important rivers being marked, more or less, by these alluvial flats. By the Shannon, the alluvium is found below high water, and is often capped by drift accumulations forming low islands. On the south side of the mouth of the Shannon there are grits and yellow sandstones that have been classed as Upper Old Red. Silurian rocks (Llandovery) occur at Ballyvar and elsewhere, but so slightly developed as to be comparatively insignificant.

In the lists which follow there are enumerated—of Phanerogamia, 459 species; Vascular Cryptogamia, 18; Characeæ, 4; Musci, 84; Hepaticæ, 14: in all, 579 species. Though this number reaches nearly to one-half of the Irish flora, it cannot be said to represent the

total of the plants of the district. The names of several comparatively common species do not appear in these lists, but it is not to be assumed that all such are really absent from the flora. In the case of even the most common it has not been deemed wise to assume their occurrence unless actually noted in the field; and to pass by such without note is easier than to overlook a rarity. Amongst the Musci one species, *Cinclidotus riparius* is an addition to the British flora; to give a full account of the mosses would, however, entail another winter's work, and the following list is an incomplete one. The Hepaticæ have been still less perfectly catalogued, though it must be said that a rich flora of these plants cannot be hoped for, as Nature has not afforded them the most suitable habitats. It is singular that this district, lying midway between two remarkable floras, is scarcely enriched by any outliers or vestiges of either. Killarney is but half of a degree further south, but then the physical conditions are totally unlike. Instead of lofty mountains, with thickly-wooded and deep sheltering glens, we have on the Shannon low boggy hills, and the woods are elevated but slightly above sea-level. About an equal distance to the north we meet with, in the Burren flora, a vegetation very different from that of Killarney, and scarcely less interesting. The prominent plants of the Burren are absent from South Clare and the Shannon estuary, and this absence must be accounted for on geological considerations. The warm limestone rocks of the Burren, intersected as they are everywhere by their humid fissures, offer unique conditions which do not obtain, to any extent, elsewhere in Ireland. The speciality of the conditions in north-west Clare is expressed in its special flora; but this flora, due to geological influences, is confined to the area in which those influences operate.

The geographical relations of the flora here recorded do not call for much comment. We notice an absence of any plants special to the locality, and the usual preponderance of the common species grouped in Watson's "British Type." An analysis of the following lists shows that 75 per cent. of the plants enumerated must be classed under the British type, 15 per cent. under the English type, 2½ per cent. are of the Atlantic type, and 1 per cent. only are placed in the Scottish type. But one plant, *Orchis pyramidalis*, can be credited to the Germanic type, and the Highland type is without any representation. There remain 6½ per cent. uncertain and unclassed. *Cinclidotus riparius* is new to the British flora, and *Rubus althæifolius* is a bramble not previously recorded as Irish. The variety *intermedius* of *R. cæsius* is also an addition to the Irish flora, and likewise the var.

densa of *Sagina maritima*. *Potamogeton Friesii* (*mucronatus*) has been erroneously recorded for the North of Ireland; it is now published with certainty as an Irish plant.

Additions to District I. of the Cybele Hibernica.

Raphanus maritimus.
Sagina maritima, var. densa.
Rubus cæsius, var. intermedius.
Arenaria leptoclados (also new to 6).

Additions to District VI.

Ranunculus penicillatus.
Viola odorata.
Stellaria holostea.
Cerastium tetrandrum.
Vicia sylvatica.
Rubus rusticanus.
R. macrophyllus.
R. koehleri.
R. corylifolius,
var. conjungens.
R. althæifolius.
Ægopodium podagraria.
Œnanthe lachenalii.
Œ. crocata.
Scabiosa arvensis.
Bidens cernua.
Artemisia maritima.
Solanum dulcamara,
var. marinum.
Linaria vulgaris.
Scrophularia aquatica.
Veronica montana.
Mentha sativa.
Atriplex hastata.
Empetrum nigrum.
Callitriche hamulata.
Salix alba.
S. aurita.
Juncus obtusiflorus.
Typha latifolia.
Potamogeton pusillus.
P. zizii.
Zannichellia palustris.
Scirpus fluitans.
Carex ovalis.
C. extensa.
Holcus mollis.
Bromus racemosus.
Equisetum maximum.
E. palustre.

My best thanks are due to those friends whose kind assistance and advice on critical points have rendered the statements in this Report more reliable. For the pains taken with a number of the plants here enumerated, I feel especially grateful to Professor Charles C. Babington, F.R.S., Mr. G. A. Holt, of Manchester, and Mr. A. Bennett, F.L.S., of Croydon.

LIST OF SPECIES.

RANUNCULACEÆ.

[*Ranunculus trichophyllus*, Chaix. A plant which seemed to be this grows sparingly on Scattery Island; but as the specimen was lost before being critically examined, it is not certain.]

R. Baudottii, Godr. Marshes by the Fergus at Ennis; also at Beal Point, Ballybunion, and north side of Tralee Bay.

R. penicillatus (Dum.). In the Fergus at Ennis, and in the Feale, near Listowel.

R. peltatus, Fries. Beal Point; not common.

R. hederaceus, Linn. Doonbeg, Beal Point.

R. sceleratus, Linn. Clare Castle, Lough Senan, Ferry Bridge, Foynes.

R. flammula, Linn. Marshes, frequent.

R. lingua, Linn. Rare; but abundant in a marsh near Doonbeg.

R. acris, Linn. Common in many places.

R. repens, Linn. Common.

R. bulbosus, Linn. Not common.

Caltha palustris, Linn. Abundant at Ennis.

NYMPHACEÆ.

Castalia alba, Salisb. Ballycar Lake, and in several places between Askeaton and Foynes, but not common.

Nymphæa lutea, Linn. (*Nuphar*, Sm.). Ditches in Monmor bog; also near Foynes and Askeaton.

PAPAVERACEÆ.

Papaver dubium, Linn. Ballycar, Foynes, &c., but not common.

[*P. somniferum*, Linn. Is not infrequent in cultivated fields.]

Glaucium flavum, Crantz. Shore at Kilrush, and abundant on Scattery Island.

FUMARIACEÆ.

Fumaria officinalis, Linn. Borders of fields, Ringmoylan, &c.; not common.

CRUCIFERÆ.

Nasturtium officinale. R. Br. Springs and shallow streams.

N. amphibium, R. Br. Abundant by the Fergus at Ennis.

Barbarea vulgaris, R. Br. Listowel, Ardfert.

Arabis hirsuta (Linn.). Limestone quarry at Ringmoylan, and limestone rocks at Askeaton; not common.

Cardamine hirsuta, Linn. Walls at Clare Castle.

C. pratensis, Linn. Wet pastures.

Sisymbryum officinale, Linn. Roadsides and wastes; common.

Brassica campestris, Linn. Clare Castle, Doonbeg; not common.

Sinapis nigra, Linn. In crops; rare, and a casual.

S. arvensis, Linn. Common.

Cochlearia officinalis, Linn. Kilrush, Foynes, &c.; common on the coast.

Thlaspi arvense, Linn. On limestone at Askeaton.

Capsella bursa-pastoris (Linn.). Roadsides; frequent.

Senebiera coronopus (Gaert.). On the quay at Clare Castle.

S. didyma, Pers. Abundant at Ennis, and on roadsides from Foynes to Listowel.

Raphanus maritimus, Sm. Sandy shore at Ballybunion.

RESEDACEÆ.

Reseda luteola, Linn. Clare Castle, Sixmilebridge, Lough Senan, Kilrush, Askeaton, Foynes.

VIOLACEÆ.

Viola palustris, Linn. Sixmilebridge, Lough Senan, Tullagher.

V. odorata, Linn. Plentiful on gravelly ground by roadside between Sixmilebridge and Newmarket.

V. hirta, Linn. Plentiful on limestone rocks at Askeaton, and in quarries south-east of Foynes.

V. sylvatica, Fries. Common on banks and pastures.

V. lutea var. *curtisii*, Forst. Doonbeg, Beal Point, Ballybunion; abundant on the sands.

V. tricolor, Linn. Sandy waste ground.

,, var. *arvensis*, Murr. Sixmilebridge, Kilrush, &c.

DROSERACEÆ.

Drosera rotundifolia, Linn. Peat bogs; common.

D. intermedia, Hayne. Bogs between Kilrush and Kilkee; abundant in places.

D. anglica, Huds. Rare, but abundant in bogs north of Carrigaholt.

,, var. *obovata*, M. and K. Sparingly in a bog, north of Carrigaholt. Apparently this, but less decidedly marked than the North of Ireland plant.

POLYGALACEÆ.

Polygala vulgaris, Linn. Kilrush, Carrigaholt, Askeaton; not very common.

CARYOPHYLLACEÆ.

Silene inflata, Sm. Clare Castle; not common.

S. maritima, With. By the Shannon occasionally, but not abundant.

Lychnis dioica, Sibth. Coast south of Ballybunion; rare.

Sagina procumbens, Linn. Common.

S. apetala, Linn. Bridge at Clare Castle, walls about Kilrush, and Foynes.

S. maritima, Don. Kilrush, north side of Tralee Bay.

,, var. *S. densa*, J. Plentiful in large patches on dry sandy banks by the church at Ballybunion.

S. nodosa, E. Meyer. Bogs at Ballycar; also at Askeaton, and in damp grassy places in sandhills at Beal Point.

Arenaria peploides, Linn. Sandy shores; common.

A. serpyllifolia, Linn. Limestone rocks, and sandy shores.

A. leptoclados, Guss. Walls of Ferrybridge, and limestone quarry south-east of Foynes.

Stellaria media (Linn.) Vill. Fields and waste ground.

S. holostea, Linn. Hedge banks; frequent.

S. graminea, Linn. Hedges; frequent.

S. uliginosa, Murr. Marshy places; frequent.

Cerastium glomeratum, Thuil. Dry places at Kilrush, Foynes, &c.; not common.

C. triviale, Link. Common.

C. tetrandrum, Curt. By the shore at Kilrush, and abundant at north side of Tralee Bay.

Spergularia rupestris, Lebel. Kilrush, Ringmoylan, and abundant on sea cliffs at Ballybunion.

S. neglecta, Kindb. Clare Castle, and salt marsh at Foynes.

Spergula arvensis, Linn. Cultivated fields; frequent.

MALVACEÆ.

Malva sylvestris, Linn. Askeaton, Beal Point, Ballybunion; frequent on waste ground.

Althæa officinalis, Linn. Sparingly by roadside south of Ballybunion, and abundant by damp ditches close to Beal Castle. The information received from a cottager at the spot was to the effect that the plant was not cultivated, and "always grew there."

HYPERICACEÆ.

Hypericum androsæmum, Linn. Sparingly in woods at Rinekirk, Kilrush, and Foynes.

H. tetrapterum, Fries. Rinekirk, Kilrush, and Foynes.

H. perforatum, Linn. Ennis, Ballycar, Rinekirk, Askeaton, Ballybunion.

H. dubium, Leers. Limestone rocks by shore at Askeaton.

H. humifusum, Linn. Kilrush; not common.

H. pulchrum, Linn. Dry banks; Kilrush, &c.

H. elodes, Linn. Tullagher Lake, north of Kilrush, and abundant on Monmor bog.

GERANIACEÆ.

Geranium molle, Linn. Common.

G. pusillum, Linn. Waste ground by the old Charter School near Ringmoylan, north of Pallaskenry; rare.

G. dissectum, Linn. Common through the district.

G. columbinum, Linn. Plentiful on limestone at Askeaton; also in quarry, and on rocky limestone pastures at Foynes.

G. lucidum, Linn. Abundant about Patrick's Well and Foynes.

G. robertianum, Linn. Rocks and banks; frequent.

Erodium cicutarium, Smith. Common on roadsides at north side of Tralee Bay.

OXALIDACEÆ.

Oxalis acetosella, Linn. Frequent.

LINACEÆ.

Linum catharticum, Linn. Dry pastures; in profusion on sandhills at Ballybunion.

Radiola linoides (Linn.). By Lough Senan, and abundant in places between Kilrush and Carrigaholt, also between Ballybunion and Kerry Head.

CELASTRACEÆ.

Euonymus europæus, Linn. Askeaton rare, but frequent in woods between Foynes and Glin.

LEGUMINOSÆ.

Ulex europæus, Linn. Frequent.

Medicago lupulina, Linn. Roadsides Sixmilebridge, Askeaton, and Foynes to Glin.

Trifolium pratense, Linn. Pastures and wastes; common.

T. repens, Linn. Damp pastures; common.

T. fragiferum, Linn. Muddy salt flats at Beal Point and Ballybunion, also abundant on north side of Tralee Bay.

T. procumbens, Linn. Limestone rocks, and roadsides, Ennis, Sixmilebridge, and Askeaton; frequent.

T. minus, Sm. Pastures, banks, and wastes; common.

Lotus major, Scop. Abundant at Ennis, Lough Senan, and by the Shannon above and below Kilrush.

Anthyllus vulneraria, Linn. Sixmilebridge, Carrigaholt, Foynes; frequent on limestone.

Vicia hirsuta, Koch. Limestone rocks at Askeaton, and occasionally to Foynes.

V. sylvatica, Linn. Plentiful in Ringmoylan Wood.

V. cracca, Linn. Frequent on hedge banks.

V. sepium, Linn. Roadsides and banks; common.

Lathyrus pratensis, Linn. Kilrush and Carrigaholt; frequent.

L. macrorrhizus, Wimm. Rinekirk, Foynes.

ROSACEÆ.

Prunus communis, Linn. Hedges and thickets.

Spiræa ulmaria, Linn. Pastures and waysides; common.

Agrimonia eupatoria, Linn. Sixmilebridge, Kilrush, Askeaton, Foynes, Tarbert, Listowel.

Alchemilla vulgaris, Linn. Apparently not common.

Potentilla anserina, Linn. Roadsides and waste ground; common.

P. reptans, Linn. Ennis, Kilrush, Patrick's Well, Foynes; frequent.

P. tormentilla, Nesl. Common.

P. fragariastrum, Ehr. Dry banks; frequent.

[*Rubus rhamnifolius*, W. and N. Prof. Babington remarks on the specimen sent under this name "probably."]

Rubus rusticanus, Merc. (*R. discolor* Auct. Brit.). Ballycar, Sixmilebridge, Kilrush, Patrick's Well, Askeaton, Foynes.

R. leucostachys, Sm. Hedge bank between Kilrush and Moyne Point. "The form found at Malvern, and named by Lees as *R. vestitus* var. *argenteus*" (C. C. B.).

R. villicaulis, W. and N. Heathy hillside near Sixmilebridge; plentiful.

R. macrophyllus, Weihe. Doonbeg; probably common.

R. rosaceus, Weihe. By the Shannon, near Rinekirk.

R. koehleri, Weihe. Ballycar, and in woods at Foynes; a very prickly form.

R. lejeunii, Weihe. With the preceding species at Foynes.

R. corylifolius, Sm. Patrick's Well, and frequent from Askeaton to Foynes.

Var. β *conjungens*, Bab. On limestone rocks by the shore at Askeaton.

R. althæifolius, Host. Plentiful in a small ravine (Moyarta River) by the shore at the north end of Carrigaholt, Co. Clare. More sparingly on limestone rock, near the shore at Askeaton, Co. Limerick.

R. scabrosus, Müll. (*R. tuberculatus*, Bab. ?). Woods at Foynes.

R. cæsius, Linn., var. δ *intermedius*, Bab. In profusion on the sandhills at Ballybunion, and more sparingly on the rocks a little to the north.

Geum urbanum, Linn. Roadsides and banks, Ballycar, Foynes, &c.; not plentiful.

Rosa spinosissima, Linn. Askeaton, and thence to Foynes, occasionally.

R. tomentosa, Sm. Doonbeg; not common.

R. canina, Linn. Hedge banks and thickets; frequent, but not abundant.

R. arvensis, Huds. Clare Castle, Newmarket, Sixmilebridge, Askeaton, Foynes; frequent.

Cratægus oxyacantha, Linn. Hedges and copses.

Pyrus aucuparia, Gaert. Woods at Foynes; not common.

LYTHRACEÆ.

Lythrum salicaria, Linn. Ennis, Kilrush, Patrick's Well, Foynes, Glin; frequent.

Peplis portula, Linn. Marshes at Tullagher, and on Scattery Island; not common.

ONAGRACEÆ.

Epilobium hirsutum, Linn. Ennis, Doonbeg, Patrick's Well, Foynes, Ballybunion; frequent.
E. parviflorum, Schreb. Ennis, Doonbeg, Ballybunion; common.
E. montanum, Linn. Sixmilebridge, Doonbeg, Foynes; common.
E. obscurum, Schreb. Doonbeg, Kilrush, Ballybunion; common.
E. palustre, Linn. Ballycar, Lough Senan; local.
Circæa lutetiana, Linn. Woods and thickets; common.

HALORAGACEÆ.

Myriophyllum alterniflorum, D. C. Lough Senan; not common.
Hippuris vulgaris, Linn. Doonbeg, Lough Senan, Tullagher, Askeaton to Foynes; frequent.

CRASSULACEÆ.

Sedum acre, Linn. Ennis, Kilrush, Foynes, Ballybunion; abundant.
S. reflexum, Linn. Walls and roofs at Newmarket; rare.
Cotyledon umbilicus, Linn. Kilrush; abundant at Foynes.

SAXIFRAGACEÆ.

Saxifraga tridactylites, Linn. Walls of old church on Scattery Island, common on the limestone at Askeaton and Foynes, walls at Listowel.
Chrysoplenium oppositifolium, Linn. By rocky streams.
Parnassia palustris, Linn. Bogs at Ballycar.

UMBELLIFERÆ.

Hydrocotyle vulgaris, Linn. Marshes and bogs; common.
Sanicula europæa, Linn. Woods, Foynes, &c.
Eryngium maritimum, Linn. Sands at Doonbeg, and on north side of Tralee Bay.
Apium graveolans, Linn. In profusion about Ballybunion; common by the Shannon estuary, reaching to four miles inland at Patrick's Well.
A. nodiflorum, Linn. Frequent; common from Askeaton to Foynes.
A. inundatum, Reich. Monmor bog, Tullagher; common.
Ægopodium podagraria, Linn. Plentiful at Ennis.
Bunium flexuosum, With. Kilrush, Foynes; not common.

Pimpinella magna, Linn. Roadsides and ditch-banks near Rinekirk, and about Foynes.

P. saxifraga, Linn. Abundant at Askeaton and Foynes.

Sium erectum, Huds. (*S. angustifolium*, Linn.). By the Fergus at Ennis, and abundant in a ditch at Doonbeg.

Œnanthe lachenalii, Gmel. Abundant in salt marshes at Foynes and Ballybunion.

Œ. crocata, Linn. Ennis, Kilrush, Foynes, Ballybunion.

Œ. phellandrium, Lamk. Abundant by the Fergus at Ennis, Foynes to Glin, occasionally.

Fœniculum officinale, Linn. Railway bank in slob-land near Foynes.

Crithmum maritimum, Linn. Sparingly on rocks by the Shannon above Kilrush.

Angelica sylvestris, Linn. Common at Ennis, and frequent on rocks at Ballybunion.

Pastinaca sativa, Linn. Sparingly amongst potatoes at Foynes; a casual.

Heracleum sphondylium, Linn. Frequent in waste places.

Daucus carota, Linn. Fields and banks, in profusion.

Torilis anthriscus, Huds. Roadsides and banks; common.

T. nodosa, Huds. Sixmilebridge, Ballingrane, Ardfert.

Scandix pecten-veneris, Linn. Borders of cultivated fields at Kilrush and Askeaton, but not common.

Chærophyllum sylvestre, Linn. Ennis, and Foynes to Glin, but not abundant.

Conium maculatum, Linn. Clare Castle, Monmor bog, Ballybunion; abundant in places.

Smyrnium olusatrum, Linn. Quay at Clare Castle, abundant on Scattery Island, and about Foynes, occasionally.

HEDERACEÆ.

Hedera helix, Linn. Common.

CAPRIFOLIACEÆ.

Sambucus ebulus, Linn. In plenty on roadside a little west of Ardsollus Station, also near Rinekirk and Patrick's Well, and abundant on waste ground at Askeaton.

S. nigra, Linn. Frequent throughout the district.

Lonicera periclymenum, Linn. Hedges; common.

RUBIACEÆ.

Sherardia arvensis, Linn. Borders of sandy fields, Sixmilebridge, Patrick's Well, Foynes, Ardfert.

Asperula cynanchica, Linn. Sandy shores at Doonbeg and Foynes, and abundant on Sandhills at Beal Point, Ballybunion, and Tralee Bay.

A. odorata, Linn. Sixmilebridge, &c.; not common.

Rubia peregrina, Linn. Wood at Ringmoylan, rocks at Askeaton, limestone quarry at Foynes.

Galium verum, Linn. Common throughout the district.

G. saxatile, Linn. Kilrush, &c.; frequent.

G. aparine, Linn. Frequent.

DIPSACACEÆ.

Dipsacus sylvestris, Huds. Doonbeg, sparingly, plentiful by the Shannon above and below Kilrush, in several places on the coast near Foynes.

Scabiosa succisa, Linn. Foynes, Ballybunion, &c.; frequent.

S. (*Knautia*) *arvensis*, Linn. Railway banks in several places near Adare and Askeaton.

COMPOSITÆ.

Eupatorium cannabinum, Linn. Abundant at Ballycar, occasionally about Foynes, Beal Point, and Ballybunion.

Petasites vulgaris, Linn. By streams; common.

P. fragrans, Presl. Naturalized in wood at Foynes.

Tussilago farfara, Linn. Damp soil; common.

Aster tripolium, Linn. Muddy shores and maritime rocks; frequent.

Bellis perennis, Linn. Common.

Solidago virgaurea, Linn. Doonbeg, and plentiful on limestone rocks at Foynes.

Inula helenium, Linn. Plentiful in two places by the shore at Beal Point.

Pulicaria dysenterica, Linn. Kilrush, Foynes, Glin, Ballybunion; frequent.

Gnaphalium uliginosum, Linn. Lough Senan; seems not common.

Antennaria dioica, Linn. Dry pastures at Foynes.

Achillæa ptarmica, Linn. Kilrush, Ballybunion; frequent.

A. millefolium, Linn. Roadsides and waste ground; common.

Matricaria inodora, Linn. Waste ground; common.

M. chamomilla, Linn. Plentiful at Ballybunion and Beal Castle.

Chrysanthemum leucanthemum, Linn. Common.

C. segetum, Linn. Cultivated fields; frequent.

Artemisia vulgaris, Linn. Dry banks; frequent.

A. maritima, Linn. Abundant on muddy flats by the shore above Foynes.

Senecio vulgaris, Linn. Common.

S. sylvaticus, Linn. Waste ground at Askeaton, and from Foynes to Glin; not common.

S. jacobaea, Linn. Common.

S. aquaticus, Huds. Wet places; common.

Bidens tripartita, Linn. Ballycar, Lough Senan, also near Doonbeg, and Beal point; frequent in bog drains.

B. cernua, Linn. Lough Senan; less common.

Carlina vulgaris, Linn. Sixmilebridge; not common.

Arctium minus, Schk. Clare Castle, Ballycar, Beal Castle; general, sometimes abundant.

Centaurea nigra, Linn. Common.

C. scabiosa, Linn. Railway banks Adare to Ballygrane, and near Askeaton; rare.

Carduus lanceolatus, Linn. Common.

C. arvensis, Linn. Common.

C. palustris, Linn. Common.

C. pratensis, Huds. Bogs at Tullagher, and between Askeaton and Foynes.

Silybum marianum (Linn). Waste ground at Askeaton, and on the shore at Beal Point.

Lapsana communis, Linn. Clare Castle, &c.

Hypochaeris radicata, Linn. Waste ground and banks; common.

Leontodon hirtus, Linn. (*Thrincia*, D. C.). Dry pastures at Foynes, and abundant on the sandhills at Ballybunion.

L. autumnalis, Linn. Damp pastures; common,

L. taraxacum, Linn. Common.

Sonchus oleraceus, Linn. Kilrush, &c.; common.

S. asper, Hoffm. Frequent; abundant at Ennis.

S. arvensis, Linn. Cultivated fields; common.

Crepis virens, Linn. Ballybunion, &c.; common.

Hieracium pilosella, Linn. Dry banks; frequent.

CAMPANULACÆ.

Jasione montana, Linn. Abundant on rocks at Ballybunion.

Campanula rotundifolia, Linn. Hills near Sixmilebridge; apparently not common.

ERICACEÆ.

Calluna vulgaris (Linn.). Heaths, Ballycar, &c.; frequent.

Erica tetralix, Linn. Ballycar; frequent on bogs.

E. cinerea, Linn. Kilrush, &c.; frequent.

Vaccinium myrtillus, Linn. Sixmilebridge and Foynes; not abundant.

V. oxycoccos, Linn. Plentiful on parts of Monmor bog.

AQUIFOLIACEÆ.

Ilex aquifolium, Linn. Sixmilebridge; not common.

OLEACEÆ.

Ligustrum vulgare, Linn. By the Fergus at Ennis, Askeaton to Foynes, and often seen in hedges.

GENTIANACEÆ.

Chlora perfoliata, Linn. Near Askeaton in plenty, also near Ballybunion.

Erythræa pulchella (Swartz). Abundant on the sandhills at Ballybunion, occurs also at Beal Point, and north side of Tralee Bay.

E. centaureum (Curtis). Ballycar, Sixmilebridge, Foynes, Glin; frequent.

Gentiana campestris, Linn. Rocks at Ballybunion, and near Ballingarry, north-west of Kerry Head.

CONVOLVULACEÆ.

Convolvulus sepium, Linn. Ennis, Kilrush, Foynes, Askeaton, Ballybunion.

C. soldanella, Linn. In great abundance on sandhills at north side of Tralee Bay.

BORAGINACEÆ.

Symphytum officinale, Linn. By the Fergus at Ennis, Foynes to Glin, and abundant at Beal Point.

Myosotis palustris, With. Ennis, Ballycar, Curragh Chace.

M. cæspitosa, Schultz. Lough Senan; less common than the preceding.

M. arvensis, Hoffm. Ballycar, Listowel; frequent.

M. versicolor, Reich. Sixmilebridge; not very common.

SOLANACEÆ.

Solanum dulcamara, Linn. (var. *marinum*, Bab.). Sparingly on gravelly shore at upper side of Kilrush.

OROBANCHACEÆ.

Orobanche hederæ, Duby. Sparingly, on ivy, a little south-east of Foynes, and again near Askeaton.

SCROPHULARIACEÆ.

Verbascum thapsus, Linn. Sparingly at Pallaskenry, Askeaton, and quarry at Foynes.

Linaria vulgaris, Mill. By the railway line at Adare.

Scrophularia nodosa, Linn. Ballycar, Kilrush, Askeaton, Foynes; frequent.

S. aquatica, Linn. Abundant by the Fergus at Ennis, and several places between Kilrush and Carrigaholt; also Foynes, Beal Castle, and Ballybunion; more common than the preceding.

Melampyrum pratense. Linn. Monmor bog; also near Kilrush, and abundant in wood at Ringmoylan.

Mimulus luteus, Linn. This introduced plant is abundant by the Fergus at Ennis.

Pedicularis palustris, Linn. Marsh at Ballycar.

Rhinanthus crista-galli, Linn. Common.

Bartsia odontites, Huds. Damp waste ground; common.

Euphrasia officinalis, Linn. Kilrush, and abundant on the sandhills at Ballybunion and Beal Point.

Veronica scutellata, Linn. Monmor bog, Tullagher Lake.

V. anagallis, Linn. Abundant at Ennis.

V. beccabunga, Linn. Kilrush, &c.

V. chamædrys, Linn. Common.

V. montana, Linn. Ballycar; not common.
V. officinalis, Linn. Quarry at Kilrush; not abundant.
V. serpyllifolia, Linn. Frequent.
V. arvensis, Linn. Fields about Foynes.
V. agrestis, Linn. Ballybunion, &c.
V. polita, Fries. Fields at Foynes.
V. buxbaumii, Ten. Clare Castle, Kilrush, Foynes to Glin, Ballybunion; frequent.

LABIATÆ.

Mentha aquatica, Linn. Ennis, Ballycar, Ballybunion.
M. sativa, Linn. Ballybunion.
Lycopus europæus, Linn. Wet places; common in the district.
Origanum vulgare, Linn. Abundant on a roadside near Patrick's Well.
Thymus serpyllum, Linn. Ballycar, Kilrush, &c.
Scutellaria galericulata, Linn. Wood at Ballycar; rare.
Brunella vulgaris, Linn. Common, but not abundant.
Nepeta glechoma, Linn. Sixmilebridge, Askeaton, Foynes.
Lamium purpureum, Linn. Cultivated fields; common.
Galeopsis tetrahit, Linn. Sixmilebridge; frequent.
Stachys sylvatica, Linn. Sixmilebridge and Scattery Island.
S. palustris, Linn. Sixmilebridge; frequent.
S. arvensis, Linn. Roadside from Newmarket to Sixmilebridge; rare.
Teucrium scorodonia, Linn. Quarry at Foynes; not abundant.

VERBENACEÆ.

Verbena officinalis, Linn. Plentiful on waste ground at Askeaton, roadside at Ardfert; rare.

LENTIBULARIACEÆ.

Utricularia minor, Linn. Ballycar, Tullagher Lake, abundant on Monmor bog.

PRIMULACEÆ.

Primula vulgaris, Linn. Common.
Glaux maritima, Linn. Abundant in many places.
Anagallis arvensis, Linn. Common on light soil.
A. tenella, Linn. Common in boggy places.
Samolus valerandi, Linn. Occasionally by Shannon, at the upper end of the estuary; bogs at Ballycar and Carrigaholt; frequent at Foynes.

PLUMBAGINACEÆ.

Statice bahusiensis, Fries. Ringmoylan, and mud-flats above Foynes; rare.
Armeria maritima, Willd. Kilrush, Ballybunion; frequent.

PLANTAGINACEÆ.

Plantago coronopus, Linn. Rocky shores, Foynes, Ballybunion.
P. maritima, Linn. Common by the Shannon.
P. lanceolata, Linn. Common.
P. major, Linn. Common.
Littorella lacustris, Linn. Shores of Lough Fin, east of Newmarket.

CHENOPODIACEÆ.

Suæda maritima, Linn. Doonbeg, Scattery Island.
Salsola kali, Linn. Shore at Beal Point; rare.
Chenopodium album, Linn. Common.
Beta maritima, Linn. Foynes; not common.
Salicornia herbacea, Linn. Foynes; not abundant.
Atriplex littoralis, Linn. Scattery Island; rare.
A. angustifolia, Wahl. Kilrush, &c.
A. hastata, Linn. Common on shores of the Shannon.
A. babingtonii, Woods. Clare Castle.

POLYGONACEÆ.

Rumex conglomeratus, Murr. Ennis, Foynes, Kilrush; frequent.
R. sanguineus, Linn. (var. *viridis*, Sibth.). Ennis.
R. obtusifolius, Linn. Common.
R. crispus, Linn. Waste ground.
R. acetosa, Linn. Frequent.
R. acetosella, Linn. Stony pastures.
Polygonum amphibium, Linn. Doonbeg, Foynes; frequent.
P. persicaria, Linn. Common.
P. hydropiper, Linn. Common in wet places.
P. aviculare, Linn. Waste ground and roadsides; common.
P. convolvulus, Linn. Foynes, Glin.

EMPETRACEÆ.

Empetrum nigrum, Linn. Ballycar, and heaths south-west of Ballybunion; rare.

EUPHORBIACEÆ.

Euphorbia helioscopia, Linn. Cultivated fields; common.
E. paralias, Linn. Abundant on sandhills at north side of Tralee Bay.
E. portlandica, Linn. Sparingly on sandhills at Ballybunion.
E. peplus, Linn. Common in fields.

CALLITRICHACEÆ.

Callitriche verna, Linn. Lough Senan, Beal Castle; common.
C. hamulata, Kutz. Ditch at Rinekirk; perhaps frequent.

URTICACEÆ.

Parietaria officinalis, Linn. Old walls; frequent.
Urtica urens, Linn. Common at Ennis, abundant from Askeaton to Foynes.
U. dioica, Linn. Common.
Humulus lupulus, Linn. Hedge bank close to Ballycar railway station; an escape.

AMENTIFERÆ.

Salix alba, Linn. Sixmilebridge, and frequent.
S. viminalis, Linn. Ballycar, Sixmilebridge.
S. cinerea, Linn Common.
S. aurita, Linn. Common.
S. caprea, Linn. Less common.
S. repens, Linn. Boggy heaths, and in sandhills; common.
Myrica gale, Linn. Doonbeg and Tullagher; not common.
Alnus glutinosa, Gaert. Damp thickets.
Quercus robur, Linn. Dwarf and stunted in old natural wood on the shore at Ringmoylan.
Corylus avellana, Linn. Thickets.

HYDROCHARIDACEÆ.

Hydrocharis morsus-ranæ, Linn. Abundant, and flowering in drains by the Fergus at Ennis.

ORCHIDACEÆ.

Orchis mascula, Linn. Frequent.
O. maculata, Linn. Abundant.

O. pyramidalis, Linn. Sixmilebridge, roadside west of Limerick, Patrick's Well, Ringmoylan, Askeaton, Foynes; plentiful.

Gymnadenia conopsea, R. Br. Heaths at Ballycar, Patrick's Well, frequent from Askeaton to Foynes.

Habenaria viridis, R. Br. Foynes; not common

H. bifolia, R. Br. Plentiful on Monmor bog.

Listera ovata, R. Br. Curragh Chace, east of Askeaton; also in wood at Foynes.

Epipactis latifolia, All. Woods at Foynes; not common.

IRIDACEÆ.

Iris pseud-acorus, Linn. Common.

I. fœtidissima, Linn. Margin of Ballycar Lake, near Ennis; possibly introduced, but has the aspect of a native.

ALISMACEÆ.

Alisma plantago, Linn. Ennis; common.

A. ranunculoides, Linn. Marshes, and in shallow water; common.

Triglochin maritimum, Linn. Abundant at Ballybunion.

T. palustre, Linn. Frequent.

LILIACEÆ.

Endymion nutans, Dum. Woods.

MELANTHACEÆ.

Narthecium ossifragum, Huds. Peat bogs; abundant from Kilrush to Kilkee.

JUNCACEÆ.

Juncus maritimus, Sm. Frequent by the Shannon.

J. effusus, Linn. Common.

J. conglomeratus, Linn. Common.

J. glaucus, Sibth. Lough Senan, and abundant at Beal Castle.

J. obtusiflorus, Ehr. Marsh by the railway line above Foynes.

J. acutiflorus, Ehr. Common.

J. lamprocarpus, Ehr. Abundant at upper end of the estuary.

J. supinus, Moench. Lough Senan; not common.

J. squarrosus, Linn. Heath at Ballycar.

J. gerardi, Lois. Muddy flats at north side of Tralee Bay.

J. bufonius, Linn. Lough Senan.

Luzula multiflora, Lej. Moors and bogs.

TYPHACEÆ.

Typha latifolia, Linn. Ennis, Lough Senan, Tullagher, Doonbeg; frequent in Clare.

Sparganium ramosum, Huds. Common.

S. minimum, Fries. Frequent in bogs about Ennis, abundant in Lough Senan and Tullagher Lake; also Blue Lough and Curragh Chace.

ARACEÆ.

Arum maculatum, Linn. Sixmilebridge; common.

LEMNACEÆ.

Lemna trisulca, Linn. Abundant about Ennis.

L. minor, Linn. Common.

POTAMOGETONACEÆ.

Potamogeton natans, Linn. Ponds and lakes; frequent.

P. polygonifolius, Pourr. Kilrush, Tullagher Lake, Carrigaholt; frequent.

P. rufescens, Schrad. St. Senan's Lough; not common.

P. zizii, Roth. Lough Senan.

P. perfoliatus, Linn. Abundant in the Fergus at Ennis, and in Lough Senan.

P. friesii, Rupr. (*P. mucronatus*, Schrad.) Pond near Foynes.

P. pusillus, Linn. Ponds and lakes; frequent.

P. pectinatus, Linn. River Fergus at Ennis, also at Ballybunion.

P. densus, Linn. In great abundance in the alluvial flat by the Mague from Ferry Bridge to Rinekirk.

Ruppia rostellata, Koch. Brackish ditches, Kilrush, Foynes, Ballybunion.

Zannichellia palustris, Linn. Rinekirk.

NAIDACEÆ.

Zostera marina, Linn. Scattery Island, and frequent.

CYPERACEÆ.

Schœnus nigricans, Linn. Ballycar, and abundant from Askeaton to Foynes.

Cladium mariscus, R. Br. Marshes at Blue Lough, south of Pallaskenry.

Rhynchospora alba, Vahl. Abundant on bogs from Kilrush to Kilkee.

Eleocharis palustris, R. Br. Common.

E. multicaulis, Sm. Monmor bog.

Scirpus maritimus, Linn. Frequent, and often very luxuriant by the Shannon.

S. lacustris, Linn. Abundant in the lakes of Co. Clare.

S. tabernamontani, Gm. Rinekirk, Blue Lough, Askeaton; plentiful in one spot at Ballybunion, and abundant in a ditch at Beal Castle.

S. cæspitosus, Linn. Moors.

S. fluitans, Linn. Pond by the Shannon above Kilrush.

S. savii, S. and M. Doonbeg, and by the shore at Foynes; not common.

Eriophorum polystachion, Linn. Common on bogs.

Carex pulicaris, Linn. Askeaton; not common.

C. disticha, Huds. Ennis, Foynes.

C. arenaria, Linn. Abundant on sandy shores at Doonbeg, Beal Point, Ballybunion, and Tralee Bay.

C. vulpina, Linn. Ennis, Doonbeg, Rinekirk, Beal Point, Ballybunion.

C. paniculata, Linn. Curragh Chace; not common.

C. remota, Linn. Wood at Beal Castle.

C. echinata, Good. Ballycar; frequent.

C. leporina, Linn. Kilrush; apparently not common.

C. stricta, Good. Woods of Curragh Chace; rare.

C. goodenovii, Gay. Common.

C. limosa, Linn. Bog drains at Ballycar; rare.

C. præcox, Jacq. Ballycar; not common.

C. glauca, Linn. Common.

C. flava, Linn. Common.

C. extensa, Good. Salt marsh at Foynes, and abundant in mud flats at Ballybunion.

C. hornschuchiana, Hoppe. Heaths; not common.

C. distans, Linn. Carrigaholt, Foynes, Ballybunion; plentiful on muddy shores.

C. binervis, Sm. Heaths; not common.

C. sylvatica, Huds. Woods; common in the district.

C. pseudo-cyperus, Linn. Abundant in bog drains at Ballycar.

C. hirta, Linn. Ballycar, Kilrush; not common.

C. rostrata, Stokes. Common.

C. vesicaria, Linn. Rinekirk; not very common.

C. riparia, Curt. Ennis, Ballyear, Rinekirk; frequent.

GRAMINEÆ.

Phalaris arundinacea, Linn. Ennis; not very common.
Anthoxanthum odoratum, Linn. Pastures; common.
Phleum arenarium, Linn. Sandhills at north side of Tralee Bay.
P. pratense, Linn. Common.
Phragmites communis, Trin. Frequent throughout the district.
Psamma arenaria, R. and S. Askeaton to Foynes; abundant at Tralee Bay.
Agrostis vulgaris, With. Common.
A. alba, Linn. Lough Senan, Kilrush, Foynes, Listowel.
Holcus lanatus, Linn. Roadsides and wastes; common.
H. mollis, Linn. Boggy ground, Kilrush.
Aira cæspitosa, Linn. Ballycar, Foynes; frequent.
A. caryophyllea, Linn. Kilrush.
Arrhenatherum elatius, M. and K. Roadsides and banks; common.
Trioda decumbens, Beauv. Bogs below Kilrush, limestone pastures at Foynes, rocks at Ballybunion.
Melica uniflora, Retz. Woods at Foynes; not common.
Molinia cærulea, Moench. Abundant at Ballycar, moors at Tullagher, rocks at Askeaton; frequent.
Poa annua, Linn. Common.
P. trivialis, Linn. Common.
Glyceria fluitans, R. Br. Ditches about Ennis.
Sclerochloa maritima, Lindl. Kilrush, Beal Point, Ballybunion.
S. rigida, Link. Wall at Kilrush, abundant at Askeaton, frequent at Foynes.
Briza media, Linn. Common in bogs and wet pastures.
Cynosurus cristatus, Linn. Common.
Dactylus glomeratus, Linn. Frequent.
Festuca ovina, Linn. Beal Point and Ballybunion.
F. rubra, Linn. Common through the district.
F. pratensis, Huds. Rinekirk to Foynes, occasionally in damp fields.
F. gigantea, Vill. In woods, Curragh Chace, Foynes, &c.
Bromus asper, Murr. Wood at Foynes.
B. racemosus, Linn, Damp pastures, Kilrush, Foynes.
B. mollis, Linn. Roadsides and waste ground; frequent.
Brachypodium sylvaticum (Huds.). Common and abundant.
Triticum caninum, Linn. Stony and gravelly shores on both sides of the Shannon; frequent.
T. repens, Linn. Waste ground and borders of fields; frequent.

T. junceum, Linn. Sandy shores, Doonbeg, Beal Point, abundant at Tralee Bay.

Hordeum pratense, Huds. Abundant in a salt marsh at Ringmoylan.

Lepturus filiformis, Trin. Abundant in wet, sandy flats at Ballybunion, and north side of Tralee Bay.

Lolium perenne, Linn. Common.

L. italicum, Braun. Kilrush, and Foynes to Askeaton.

EQUISETACEÆ.

Equisetum arvenis, Linn. Common.

E. maximum, Lamk. Common.

E. limosum, Linn. Common.

E. palustre, Linn. Common.

FILICES.

Polypodium vulgare, Linn. Banks and walls; not abundant.

Lastrea filix-mas, Presl. Ballycar, &c.

L. dilatata, Willd. Foynes.

Polystichum aculeatum, Roth. Roadsides, Foynes; not common.

Athyrium filix-fœmina, Roth. Kilrush.

Asplenium adiantum nigrum, Linn. Kilrush, Askeaton, Foynes; frequent, sometimes abundant.

A. trichomanes, Linn. By the Fergus at Ennis, also Sixmilebridge, Kilrush, Askeaton, Foynes; frequent.

A. marinum, Linn. Rocks above Kilrush; rare and stunted.

A. ruta-muraria, Linn. Abundant at Ennis, Kilrush, Askeaton, Foynes, Beal Castle.

Scolopendrium vulgare, Sym. Ballycar, &c.; not abundant.

Ceterach officinarum, Willd. Common on walls; very abundant, and luxuriant at Foynes.

Blechnum spicant, Roth. Kilrush; not abundant.

Pteris aquilina, Linn. Common.

Osmunda regalis, Linn. Bogs at Ballycar, and plentiful in bogs from Kilrush to Kilkee.

CHARACEÆ.

Chara fragilis, Desv. Ponds and bog drains near Ennis; plentiful.

C. hispida, Linn. Bog drains near Newmarket, Curragh Chace, Askeaton, Foynes; frequent.

C. vulgaris, Linn. By the Shannon, at Rinekirk.

Nitella opaca, Ag. Blue Lough, south of Pallaskenry.

MUSCI.

Catharinea undulata, Linn. Damp, shady banks.

Politrichum commune, Linn. Bogs; common.

Fissidens bryoides, Linn. Damp banks.

F. adiantoides, Linn. Wood at Foynes.

Campylopus brevipilus, Br. et Schimp. Foynes; very fine, but barren.

Dicranum scoparium, Linn. Woods and shady places; common.

Ceratodon purpureus, Linn. Common.

Pottia truncatula, Linn. Fields and damp banks.

Tortula muralis, Linn. Common.

,, ,, var. *β rupestre*, Schultz. Walls and limestone rocks; frequent.

T. papillosa, Wilson. On trees near Ennis; rare and barren.

T. lævipila, Brid. Limestone rocks; frequent.

T. ruralis, Linn. Roofs and dry banks.

Mollia viridula, Linn. Common.

M. crispula, Lindb. (var. *elata*, Schimp.). Abundant on limestone rocks near Foynes.

M. littoralis, Mitten. Limestone rocks near Foynes.

M. brachydontia, Lindb. (*Trichostomum mutabile*, Bruch.). Limestone rocks; not rare.

M. tortuosa, Linn. Frequent, but barren on limestone rocks and walls.

Barbula rubella (Hoff.). Quarries and waste ground; frequent.

B. brevifolia, Dicks. (*Trichostomum tophaceum*, Brid.). Limestone rocks, Ennis, Foynes; frequent.

B. rigidula, Hedw. Limestone rocks at Foynes.

B. cylindrica, Tayl. (*Tortula insulana*, De Not.). Limestone at Foynes.

B. revoluta, Schrad. Walls; frequent.

B. convoluta, Huds. Limestone, by the Shannon at Foynes.

B. unguiculata, Huds. Damp banks; frequent.

Cinclidotus riparius. On stones, by margin of the River Fergus at Ennis.

Leersia contorta, Wulf. (*E. streptocarpa*, Hedw.). Walls near Foynes.

Grimmia maritima, Turner. Maritime rocks.

G. pulvinata, Linn. Ballycar, and elsewhere; frequent.

Glyphomitrium polyphyllum, Dicks. Common.

Anœctangium mougeottii (*Zygodon*, B. & S.). Limestone rocks, Foynes; not rare.

Zygodon viridissimus, Dicks. On trees, Ennis, Pallaskenry, Foynes; frequent and fertile.

Orthotrichum affine, Schrad. Trees, Ennis, &c.

O. diaphanum, Schrad. On trees by the Fergus at Ennis.

O. cupulatum, Hoff. (var. *nudum*, Dicks.). On stones in streams at Ennis and Foynes.

O. tenellum, Bruch. Wood at Curragh Chace.

O. pulchellum, Smith. On trees, and more rarely on stones; not common.

Weissia bruchii, Lindb. (*Ulota*, Brid.). Trees at Rinekirk; and frequent.

W. phyllantha, Brid. Trees and stones; common, but barren.

Funaria hygrometrica, Linn. Common.

Pohlia nutans, Schreb. (*Webera*, Hedw.). Bogs; not rare.

P. carnea, Linn. Sides of streamlets; not uncommon.

Bryum inclinatum, Swartz. Damp banks; rare.

B. cæspiticium, Linn. Walls and banks; common.

B. argenteum, Linn. Common.

B. bicolor, Dicks. (*B. atropurpureum*, W. and M.). Waste heaps; frequent.

B. torquescens, Br. et Sch. Plentiful on walls near Foynes.

B. murale, Wilson. Walls near Foynes.

B. capillare, Linn. Common.

Breutelia chrysocoma, Dicks. (*B. arcuata*, Hedw.). Heaths.

Mnium punctatum, Schreb. Wet, rocky places; frequent.

Thuidium tamariscinum, Neck. Woods and damp banks; frequent.

Anomodon viticulosus, Linn. Walls and limestone rocks, Ballycar, Pallaskenry, &c.

Hypnum filicinum, Linn. Wet places; frequent.

H. serpens, Linn. Damp, shady ground, and tree trunks; common.

H. stellatum, Schreb. Frequent; fine, but barren at Foynes.

H. glaucum, Lamk. (*H. commutatum*, Hedw.). Wet rocks, Foynes.

H. scorpioides, Linn. Foynes; barren.

H. purum, Linn. Foynes; frequent.

H. striatum, Schreb. Woods, Kilrush, Foynes.

H. swartzii, Turner. Wood at Foynes.

H. rusciforme, Necker. In streams.

H. tenellum, Dicks. Limestone rocks at Askeaton.

H. velutinum, Linn. Rocks and stones; frequent.

H. pseudo-plumosum, Brid. (*H. plumosum*, auct. Brit.). Frequent.

H. viride Lamk. (*H. populeum*, Hedw.). Foynes.

H. lutescens, Huds. Limestone rocks at Askeaton.

H. sericeum, Linn. (*Leskea*, Hedw.). Askeaton.

H. viviparum, Neck. (*Iso. myurum*, Poll.). Foynes.

H. brevirostrum, Ehr. Woods at Foynes.
H. triquetrum, Linn. Woods at Foynes.
H. squarrosum, Linn. Foynes; common.
H. molluscum, Hedw. Limestone rocks; frequent.
" " var. *β gracile*, Boulay. Limestone rocks by the Shannon.
H. cupressiforme, Linn. Common.
H. resupinatum, Wils. Stones and rocks; frequent.
H. undulatum, Linn. Woods at Foynes.
H. cuspidatum, Linn. Common.
Parotrichum alopecurum, Linn. Foynes; frequent.
Homalia trichomanoides, Schreb. Rocks and banks; frequent.
Neckera complanata, Linn. On trees at Foynes.
Fontinalis antipyretica, Linn. In the Fergus, at Ennis.
Cryphæa arborea, Huds. On trees by the river at Ennis; also Sixmilebridge, Rinekirk, and Foynes.
Sphagnum medium, Limpr. Hills near Sixmilebridge.
S. acutifolium, Ehr. Kilrush, Foynes; common.
" " var. *rubellum*, Wilson, Sixmilebridge.
S. cuspidatum, Ehr. Sixmilebridge, Foynes.

HEPATICÆ.

Frullania dilatata, Linn. Trees and rocks; frequent.
Lejeunea hamatifolia, Hook. Rocks near Ballybunion.
L. serpyllifolia, Dicks. Common.
Radula complanata, Linn. Common on trees.
Porella platyphylla, Linn. Common.
Lepidozia reptans, Linn. Shady banks.
Diplophyllum albicans, Linn. Common.
Lophocolea bidentata, Linn. Foynes; frequent.
Plagiochila asplenoides, Linn. Shady banks.
P. spinulosa. Dicks. Frequent.
Nardia scalaris, Schrad. Moist banks; common.
Pellia epiphylla, Linn. Very common.
Metzgeria furcata, Linn. Trees and rocks; common.
Marchantia polymorpha, Linn. Common.

XXXII.

REPORT ON THE ACTINIÆ DREDGED OFF THE SOUTH-WEST COAST OF IRELAND IN MAY, 1888. BY PROFESSOR A. C. HADDON.

[Read MAY 13, 1889.]

EIGHT species of Actiniæ from three stations were entrusted to me for identification by the Dredging Committee, which was appointed to investigate the marine fauna inhabiting the deep water off the south-west coast of Ireland during the present year (1888).

(A) S. W. Ireland, in 345 fathoms.

Actinange *sp.*, four specimens; Chitonactis *sp.*, numerous specimens.

Actinange sp.

Body wall, with small pointed tubercles, irregularly scattered, dying away below so that the expanded base is smooth; pedal disc bulbous, enclosing a ball of mud. One specimen, of apparently the same species, adherent to a gastropod shell, untenanted by a hermit crab. Friable cuticle present on middle portion of body. Coronal tubercles fairly prominent; capitulum smooth. Tentacles short, inner cycles with a small basal bulb on the aboral aspect.

Colour.—In spirit the colour is whitish; cuticle greenish buff, œsophagus, disc and base of tentacles madder-brown in some specimens.

Dimensions in spirit.—Height, 30 mm.; average diameter of column, 12 mm.; diameter of bulbous base, 25 mm.

These specimens belong to the genus Actinange of Verrill, as interpreted by myself ("Revision of the British Actiniæ," Part I., *Trans. Royal Dublin Society*, 1888). There are several points of difference between these forms and those which I have elsewhere identified as *A. richardi* (Mar.). The tubercles are much smaller in size, and are pointed, closely resembling those of Chitonactis, as in the latter genus the capitulum appears to be smooth. If it had not been for the small but distinct basal bulb of the inner cycles of tentacles, I would have considered that these specimens belonged to that genus.

It is possible that after I have been able to examine these specimens anatomically I may be able to prove that they are a distinct

species from *A. richardi:* such, certainly, is my present opinion, but I prefer to leave the matter in abeyance. On the other hand, it may be a deeper-water variety of that species, the variation mainly consisting in a reduction in the size of the tubercles and in the basal bulbs of the tentacles. The specimens were preserved in a state of expansion.

? *Chitonactis sp.*

Column with numerous, few, or no tubercles; when present these are very small, and pointed; cuticle present or rubbed off, in latter case still adherent to the tubercles; basal disc greatly expanded. Column low dome-shaped in contraction or much flattened, coronal tubercles small.

Colour.—Some specimens "column white, with a double row of sparsely scattered orange tentacles, disc white, mouth and œsophagus deep orange"; other specimens "base white, upper part of body flesh colour, tentacles sparse, short, marone colour." In spirit the colour is whitish, cuticle greenish or brown; in two specimens there is a thick persistent cuticle, which is rubbed away on the upper portion of the retracted body, leaving a conspicuous white crown.

Dimensions in spirit.—Expanse of base of largest specimens 35 mm. × 18 mm.; height, 7 mm. or less. The base is usually irregularly oval in outline.

Mr. Kane, who was a member of the Expedition, gave me the colour notes which I have quoted above, as his memorandum runs:—"Log. No. 67, 345 fathoms. Several Actiniæ on *Fusus islandicus*, tenanted by Paguri; one, however, with living animal." I assume it refers to these specimens. I removed one of the more cuticular specimens from a living shell of *Cassidaria tyrrhena*, which was obtained at the same time. The Actiniæ were attached to several species of gastropods.

A very characteristic feature of this species is its remarkable power of producing buds from its greatly expanded pedal disc. In one specimen a new polyp is being formed well within the pedal disc, later it appears to entirely separate itself from its parent. This bud, so far as I can see, arises spontaneously, and not as a constriction of the oral disc.

Prof. Verrill (Am. Jour. Sci. XXIII., 1882, pp. 314, 315; Bull. Mus. Comp. Zool., 1883, p. 45, pl. vi., figs. 1, 1*c*, Rep. U. S. Fish. Com. for 1883 [1885], p. 534, fig. 177), identifies as *Sagartia abyssicola* (Kor. and Dan.), a form which is found abundantly from 69–640 fathoms off the N. E. coast of America. His species has many points

of resemblance to the above, and possibly also to the form I have referred to as *Sagartia sp.* in my "Revision." How far these or any of them are identical with Koren and Danielssen's species I am at present unprepared to state.

(B) S. W. Ireland, in 750 fathoms.

Actinerus sp.

Column.—Firm, glabrous, apparently perfectly smooth when fully extended, in contracted regions with a tendency to become verrucose; no distinct capitulum; base bulbous, as in the majority of free Actiniæ from deep water; when expanded, the upper portion of the column is much wider than the lower; the body-wall feels thick. Tentacles in preserved expanded animal, thick and short, ranged at the margin of the oral disc in two or three rows; the mesoglœa of the basal portion of the tentacles appears to be much thickened, so that there is in contraction a low, circular swollen base surmounted by the longer and more delicate distal portion of the tentacle. The tentacular crown is retractile, but apparently the circular sphincter muscle is feebly developed; when contracted, the uppermost portion of the column is somewhat puckered. The oral disc is provided with low radiating ridges, corresponding with the tentacles. In one specimen, at all events, a single large œsophageal groove is present.

Colour in preserved specimens opaque white, inner surface of œsophagus madder-brown. From a label in the bottle I find that, when alive, the tentacles were pale-salmon in colour, and mouth burnt-sienna. Mr. Kane's memorandum says: "Upper portion pale-rose colour, lower portion white; disc burnt-sienna, deepening to brown-madder; œsophageal grooves deep-salmon colour."

Dimensions when alive 4 inches in diameter "when expanded; column 3–3½ inches high, 2 inches in diameter." When preserved, the expanded disc of specimen (*a*) measures 85 mm. × 55 mm.; the base 40 mm. × 16 mm.; height, 65 mm. Specimen (*b*) contracted; average diameter, 55 mm.; height, 60 mm.

This is a fine addition to the Actiniæ of the Atlantic slope of the British Marine Area, the genus being hitherto unrecorded from this side of the Atlantic—that is, if I rightly apprehend Prof. Verrill's descriptions and figures of his genus Actinerus. (A. E. Verrill, Am. Jour. Sci. XVII., 1879; *Actinerus*, g. n., p. 474; *A. nobilis*, n. sp.: cf. Rep. U. S. Fish. Com. for 1883 [1885], p. 534, pl. vii., pp. 23, 23*a*; *A. saginatus*, n. sp., Am. Jour. Sci. XXIII., 1882, p. 315; Bull. Mus. Comp. Zoöl., 1883, p. 58). I prefer to suspend my judgment as to

the identity of our specimens with either of the above species; but I feel pretty certain as to the genus. There is at present no information by means of which the genus can be allocated a definite position in the classification of the Actiniæ.

(c) S. W. Ireland, in 50 fathoms.

Chitonactis coronata (Gosse), two specimens; *Actinange richardi* (Mar.), one specimen; *Sagartia miniata*, Gosse, two specimens; Sagartia *sp.*, one specimen; *Adamsia palliata* (Boh.), two specimens; *Bolocera tuediæ* (Johnst.), two specimens.

Chitonactis coronata (Gosse).

Base much expanded, clasping the shell of a Fusus inhabited by a hermit-crab; column transversely wrinkled, studded with small, conical-pointed warts, which do not appear to have any definite arrangement, but are more numerous at the upper portion of the contracted body, and are absent, or nearly so, on the expanded base; the coronal tubercles not distinguished from the others by size; the invection of the upper portion of the body is so complete, that no distinct orifice is present when fully contracted. The body-wall is thin, but not flaccid; the mesoglœal circular muscle is well developed. The specimens have in spirits a dirty drab colour. The œsophagus and disc have traces of a scarlet colouration. Average diameter of base, about 25 mm.; average height of contracted specimens, 15 mm.

The bibliography and distribution of this species are given in my "Revision." These two specimens are the first Irish examples of this type-species of the genus.

Actinange richardi (Mar.).

This species has recently been dealt with so fully that I have nothing more to add now, except to point out that this specimen was obtained nearer to land, and in shallower water than those which were previously trawled off the Irish Coast. The single specimen was well preserved in a fully-expanded condition, and shows the bulbous bases of the tentacles in a very marked manner.

Sagartia miniata, Gosse.

One specimen was an adult, the other a very young form, of this common species. The colouration was pale, it being the deep water variety of this variably-coloured Actinian. The other specimen which I have alluded to above as Sagartia *sp.*, is probably the same species; but as it came to me in the preserved condition, with the colour vanished, I am unable to say more about it. The other two specimens were forwarded to me alive.

Adamsia palliata (Boh.).

Two specimens of this widely-distributed species occurred at this station.

Bolocera tuediæ (Johnst.).

I believe this is the first Irish locality of this Northern species. The two specimens obtained were not of large size; the body was flesh-coloured, the tentacles madder-brown.

This collection of Actiniæ, though small, is very interesting, as it brings out some important facts in geographical distribution.

On a previous occasion (*Proc. Roy. Irish Acad.*, ser. 3, vol. 1, p. 42), I have pointed out the interdigitation off the south-west of Ireland of species which are usually respectively regarded as typically Norwegian and Lusitanian. We may now take a wider geographical range. The annual explorations of the New England seas by the U. S. Fish Commission have made known the occurrence there of many European species; we are now in a position to reciprocate and record American forms on our side of the Atlantic. In other words, several species are North Atlantic in distribution. Thanks to the liberality of the United States Government we are acquiring a precise knowledge of the marine fauna of the N. E. of America, and the range of the several species. Our knowledge of the fauna of the Atlantic slope off the British Islands is extremely imperfect, and it cannot be satisfactorily remedied until we have either a Fish Commission, who will make this one of their main objects, or a Special Commission on the lines of the "Challenger," appointed to thoroughly investigate the marine zoölogy of our seas. On a future occasion, I hope to return to a consideration of the zoö-geography of the North Atlantic basin.

A word of apology is needed for the incomplete state of this Report; the material has been handed to me very shortly before starting on a visit to the Tropics, and I have had no time to submit the Actiniæ to an anatomical investigation.—(June, 1888).

XXXIII.

A NOTE ON A DETERMINANT IN THE THEORY OF SCREWS.

By SIR ROBERT S. BALL.

[Read January 13, 1890.]

It was only quite lately that I discovered some properties of a determinant in the "Theory of Screws," which I would like to place on record in the *Proceedings* of the Academy.

Let $\theta_1, \ldots \theta_6$ be the six co-ordinates of a screw referred to a co-reciprocal system of screws of reference.

Then, denoting p_θ as the pitch we have

$$Rp_\theta = p_1 \theta_1^2 + \ldots + p_6 \theta_6^2,$$

where

$$R = \theta_1^2 + \ldots + \theta_6^2 + 2\theta_1 \theta_2 \cos(12) + 2\theta_1 \theta_3 \cos(13) + \&c.,$$

in which (12) is the angle between the 1st and 2nd screws of reference, and similarly for the others.

Let us now determine the condition that the pitch p_θ be a maximum. Then, as in ("Theory of Screws," p. 148), we have, of course, by the usual process,

$$2p_1 \theta_1 - p_\theta \frac{dR}{d_1\theta} = 0.$$

$$2p_6 \theta_6 - p_\theta \frac{dR}{d\theta_6} = 0.$$

From these six equations $\theta_1, \ldots \theta_6$ can be eliminated, and we obtain the well-known harmonic determinant which, by writing $x = 1 \div p_\theta$, becomes

$$0 = \begin{vmatrix} 1 - xp_1, & \cos(21), & \cos(31), & \cos(41), & \cos(51), & \cos(61) \\ \cos(12), & 1 - xp_2, & \cos(32), & \cos(42), & \cos(52), & \cos(62) \\ \cos(13), & \cos(23), & 1 - xp_3, & \cos(43), & \cos(53), & \cos(63) \\ \cos(14), & \cos(24), & \cos(34), & 1 - xp_4, & \cos(54), & \cos(64) \\ \cos(15), & \cos(25), & \cos(35), & \cos(45), & 1 - xp_5, & \cos(65) \\ \cos(16), & \cos(26), & \cos(36), & \cos(46), & \cos(56), & 1 - xp_6 \end{vmatrix}.$$

I already pointed out that this equation must necessarily reduce to the form

$$x^6 = 0.$$

In fact, seeing that it expresses the solution of the problem of finding a screw of maximum pitch, and that the choice may be made from a system of the sixth order, that is to say, from all the conceivable screws in the universe it is obvious that the equation could assume no other form.

What I now propose to study is the manner in which the necessary evanescence of the several coefficients is provided for. After the equation has been expanded we shall suppose that each term is divided by the coefficient of x^6 that is, by $p_1 p_2 p_3 p_4 p_5 p_6$.

The work is much simplified by a few simple theorems which are I doubt not, well known, but with which I was not acquainted until they came to light in this investigation. However, the mode of proof which I have adopted, being of a mechanical nature, may be worthy of record.

From any point draw a pencil of rays parallel to the six screws. On four of these rays 1, 2, 3, 4, we can assign four forces which equilibrate at the point. Let these magnitudes be X_1, X_2, X_3, X_4. We can express the necessary relations by resolving these four forces along each of the four directions successively. Hence

$$\begin{aligned}
X_1 \qquad\qquad &+ X_2 \cos(12) + X_3 \cos(13) + X_4 \cos(14) = 0.\\
X_1 \cos(21) + X_2 &\qquad\qquad + X_3 \cos(23) + X_4 \cos(24) = 0.\\
X_1 \cos(31) + X_2 &\cos(32) + X_3 \qquad\qquad + X_4 \cos(34) = 0.\\
X_1 \cos(41) + X_2 &\cos(42) + X_3 \cos(43) + X_4 \qquad\qquad = 0.
\end{aligned}$$

Eliminating the four forces we have

$$\begin{vmatrix}
1, & \cos(12), & \cos(13), & \cos(14)\\
\cos(21), & 1, & \cos(23), & \cos(24)\\
\cos(31), & \cos(32), & 1, & \cos(34)\\
\cos(41), & \cos(42), & \cos(43), & 1
\end{vmatrix} = 0.$$

Thus we learn that every determinant of this type vanishes identically.

Had we taken five or six forces at the point it would, of course, have been possible in an infinite number of ways to have adjusted five or

six forces to equilibrate. Hence it follows that the determinants analogous to that just written, but with five and six rows of elements respectively, are all zero.

These theorems simplify our expansion of the original harmonic determinant. In fact, it is plain that the coefficients of x^2 of x, and of the absolute term vanish identically. The terms which remain are as follows:—

$$x^6 + Ax^5 + Bx^4 + Cx^3,$$

where

$$A = \Sigma \frac{1}{p_1},$$

$$B = \Sigma \frac{\sin^2(1, 2)}{p_1 p_2},$$

$$C = \Sigma \frac{E_{123}}{p_1 p_2 p_3},$$

in which

$$E_{123} = \begin{vmatrix} 1, & \cos(12), & \cos(13) \\ \cos(12), & 1, & \cos(23) \\ \cos(13), & \cos(23), & 1 \end{vmatrix}.$$

If by $S(123)$ we denote the scalar of the product of three unit vectors along 1, 2, 3, then it is easy to show that

$$S^2(123) = E_{123}.$$

We thus obtain the following three relations between the pitches and the angular directions of the six screws of a coreciprocal system, namely,

$$\Sigma \frac{1}{p_1} = 0,$$

$$\Sigma \frac{\sin^2(1, 2)}{p_1 p_2} = 0,$$

$$\Sigma \frac{S^2(1, 2, 3)}{p_1 p_2 p_3} = 0.$$

The first of these was given in the original "Theory of Screws," the second and third I now print for the first time.

In the "Theory of Screws," p. 148, I remarked: "We are thus presented with no fewer than six formulæ involving the pitches and

angles of inclination of the six screws of a coreciprocal system," and then I mentioned the first of the three just written as an example. At the time I did not know, nor indeed did I know until a few months ago, that of these six formulæ three were merely identities. The other three which do tell us something about the coreciprocal system are given above. I may take this opportunity of saying that after some years of labour on the part of Herr Harry Gravelius, the German Edition of the "Theory of Screws" has at last appeared. In a volume of 619 pages he has translated and welded into a continuous whole, not only the original volume on the "Theory of Screws" published in 1876, but also the principal papers on the subject which I have since laid before the Academy. The title of the book is "Theoretische Mechanik Starrer Systeme, von Sir Rob. S. Ball," Herausgegeben, von Harry Gravelius: Berlin, Georg Reimer, 1889.

XXXIV.

ON THE OCCURRENCE OF ZINNWALDITE IN THE GRANITE OF THE MOURNE MOUNTAINS. By Professor W. J. SOLLAS, LL.D., F.R.S.

[Read March 15, 1890.]

The well-known presence of topaz among the beautifully crystallized minerals of the geodes of the Mourne Mountain granite led me to investigate the properties of the associated mica, which I conjectured might contain lithium. This mica occurs in well-formed crystals having the forms (001) (010) ($\bar{1}$11) for predominant faces, twinning by repeated superposition on the face *c* being common. The cleavage parallel to *c* is remarkably perfect even for a mica.

A small cleavage flake when introduced (without previous preparation) into the flame of a Bunsen's burner speedily fuses, and the flame is suffused with a superb crimson colour, evidently due to lithium. Examined with the spectroscope, in addition to the sodium and potassium spectra, the characteristic line (Li α) of lithium is seen, standing out with great intensity in the mid red. Thus there can be no doubt of the existence of lithium in the mica, and that in no inconsiderable quantity. In conjunction with my friend and pupil, Mr. Dixon, I am now engaged in making a complete analysis. When this is finished we shall hope to be able to state more definitely the proportion of lithium present.

Different examples of the mica, and even different parts of the same crystal differ widely in colour. Dark green is common, and pale violet may occasionally be observed, but those examples in which the largest proportion of lithium is indicated are silvery white in appearance, and by transmitted light quite colourless. A beautiful zonal structure, parallel with the planes 010, $\bar{1}$11, characterizes most of the crystals. In ordinary light this is apparent as thin bands of different colour running parallel to the edges of the six-sided cleavage plates. These become emphasized in polarized light between crossed nicols, except of course at the position of extinction, when the whole plate becomes uniformly dark. In crystals of more than one tint the

darker occur nearer the centre; usually green prevails in the middle of a crystal, while the outer half or so may be colourless. The extreme margin generally consists of a thin layer of a fibrous undetermined mineral, the fibres standing at right angles to the direction of the edge.

The difference in colour is associated with difference in specific gravity, which ranges from 2·8 to 3·2 or possibly over. The lighter varieties are also the lighter in colour, and contain most lithium.

Very sharply defined "schlag-figuren" were obtained, and the plane of the optic axes was found to coincide in direction with the leading ray, *i.e.* with the clino-diagonal section or plane of symmetry. Hence the mica must be referred to the species Zinnwaldite, which has not hitherto been recorded as occurring in Ireland, the only previously known lithium-bearing mica in this country being lepidolite, which has been found in County Tyrone.

The angle of the optic axes differs in different individuals and in different parts of the same crystal, varying apparently with the colour and density: thus the heavier dark-green centre of one crystal gave an angle of 44° 4′. On passing from the centre to the margin gradually increasing angles were measured, till at a place as near the edge as could be examined an angle of 52° 6′ was observed. In my paper on the Leinster granites I have described a similar difference as distinguishing the more central and more marginal parts of the muscovite crystals from Three Rock Mountain, and have explained it as the result of a passage from a more ferro-magnesian to a more alumino-alkaline mica occurring during the growth of the crystal, and presenting a very suggestive resemblance to the change in composition which accompanies the growth of many zonal felspars. In the present case a similar explanation applies; observations on the specific gravity, colour, zonal structure, and change in the value of the angle of the optic axes combine to prove that in the zinnwaldite crystal a passage can generally be traced from a more ferro-magnesian mica (meroxene in this case) to a more alumino-alkaline mica, on passing from the centre of the crystal outwards.

The change may result from changes in the composition of the successive layers added in the way of growth, or it may be partly due to successive encroachments of new material from without; in the muscovite from Three Rock Mountain there is reason to believe that the latter process has played an important part.

XXXV.

A COMMENTARY ON THE COLLOQUIES OF GARCIA DE ORTA, ON THE SIMPLES, DRUGS, AND MEDICINAL SUBSTANCES OF INDIA.

By V. BALL, LL.D., F.R.S., Director of the Science and Art Museum, Dublin.

[Read JANUARY 13, 1890.]

PART I.—INTRODUCTION.

GARCIA DE ORTA[1] was educated as a physician in Alcala and Salamanca, and practised for a time in Lisbon, where he also occupied a University Chair, which, according to one account (*Biograph. Univer.*), was of philosophy, and to another (*Nouv. Biograph. Genl.*) of Mathematics.

In the year 1534 he embarked for India, having had conferred upon him the title of Chief Physician to the King. He was first attached to the suite of Martin Affonso de Souza, who commanded the fleet, and was present with him at the establishment of the Portuguese fort and harbour at Diu, in Gujarat, which are still the property of Portugal.

In the year 1563, by which time he had acquired an intimate knowledge of the drugs, both indigenous and imported, which were then in use in India, he yielded to the solicitation of his friends and prepared for publication, at first in Latin, but afterwards in Portuguese, the work by which his name has been perpetuated. He thus avoided, as he himself hoped would be the case, being one of those men who, like the beasts that perish, leave nothing for the benefit and instruction of their posterity.

His book is sometimes referred to as being the first ever printed in India, but Brunet points out that one at least, G. de Leao's *Compendio da doct. Christæ*, preceded it, having been issued at Goa, from the same press, two years earlier, namely, in 1561.

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[1] His name was Latinized by some of his commentators into Garcias ab Horto, and in French we find the forms, de la Huerta and Dujardin!

In the opinion of some commentators, Garcia's volume contains more typographical errors than any book ever issued from a printing press—the setting up having been done by an unskilled assistant. Twenty pages of errata direct attention to, but by no means exhaust, the necessary corrections.

The colloquial style in which the information is conveyed may have had some foundation in fact (see COLL. I.), but it seems artificial in its construction, and, so far as I have yet been able to ascertain, Ruano, the questioner, may have been a mythical personage, though he is described as a Spanish physician who had come to India in search of information.

Garcia's comments on the writings of Greek and Arab authors appear to be judicious, though often expressed in perhaps unnecessarily strong language. In not a few instances they are fully justified by modern scientific investigation.

Shortly after the publication of the book, compilations and abstracts from it began to appear in various languages. One series of them, in Latin, was edited by Carolus L'Ecluse, better known as Clusius, and another series, in Spanish, by Christophorus A'Costa, who incorporated with Garcia's facts his own observations made in India. These observations were subsequently also reproduced by Clusius.

Translations of these abstracts appeared in Dutch, Italian, French, and English, most of them having been published before the end of the 17th century.

The original work is now very scarce indeed—it is said that only about six copies exist. Taking this circumstance into consideration, M. F. Ad. de Varnhagen of Vienna published a facsimile edition at Lisbon, in the year 1872, which, under the circumstances, is therefore, strictly speaking, only the second edition.

Some years ago I obtained a copy of this second edition, as I had long been familiar, from references to his work, with the name of Garcia, and the store of information which his volume contains. On examining it I was immediately impressed with the desirability of an English translation being made of it; but as I could not devote time to learning Portuguese in order to make it myself, I applied to the Academy for a grant in aid, and, in the person of Mr. C. Howard, I met with a gentleman sufficiently interested in the subject to qualify himself for the task, which he completed last year.

Before this translation can be published as a whole, however, some further revision of the text will probably be necessary; but as its publication is not contemplated by the Academy, my object now is to

give the substance of the volume in the order of the 58 colloquies into which it is subdivided, and together with it an account of the prefatory matter, which is somewhat copious, to which I have added a specially prepared bibliographical record.

Many of the colloquies refer to subjects which have no connection whatever with drugs, a large number being upon edible fruits, and some upon precious stones, &c. There are comparatively few of the indigenous plants mentioned with which I have not made some acquaintance while in India, and several I have already had to specially investigate in connection with the identification of the plants of India which were known to the Greeks[1]—and more recently in connection with plants and drugs mentioned by Tavernier, who wrote 100 years after Garcia. Colloquies I. and XLIV. on "Precious Stones" are given in full in the following pages, and will sufficiently serve to illustrate the style of the author.

Garcia has often been quoted and frequently misquoted in the past. It is hoped that what is here attempted will diminish the proportion of misquotations in the future. To each colloquy I have appended references to authors who give further and more recent information on the subjects. The number of such references might easily have been increased; but the six selected authorities afford, by the diversity and extent of the information which they convey, nearly all that is requisite for the full illustration of the various drugs which are enumerated. The first of these authorities is Carolus Clusius (L'Ecluse) who, as already stated, published an annotated and abbreviated Latin version of Christopher A'Costa's epitome of Garcia's work. The edition quoted from was printed at Antwerp (C. Plantin) in 1582. The second authority is Linschoten, who, as well as his annotator Paludanus (Bernard Ten Broeck), borrowed wholesale from Garcia. His travels were first published in 1596. The edition which is quoted from here is by Messrs. A. C. Burnell and P. A. Tiele, and was published by the Hakluyt Society in 1885. The third authority is Jacob Bontius, whose animadversions on Garcia, and general notes on the plants with Piso's annotations are given in the latter's *Indiæ Utriusque re Naturali et Medica.* Amsterdam, 1658. The fourth authority is Dr. Whitelaw Ainslie, whose *Materia Medica* was published in London in the year 1826. It contains a wonderful store of information, being especially valuable for its copious references. The fifth authority is Fluckiger and Hanbury's *Pharmaco-*

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[1] See *Proceedings*, Ser. II., vol. ii., pp. 302–346; and Ser. III., vol. i., p. 1.

graphia: a History of Drugs (London, 1874), the value of which is well known. The sixth authority is Dr. Rustomjee Naserwanjee Khory, whose *Bombay Materia Medica* supplies many deficiencies in the other works, especially as to the native estimate and uses of drugs indigenous to India. Some additional authorities which have been consulted are O'Shaughnessy, *Bengal Dispensatory and Pharmacopœia;* Col. H. Drury, *Useful Plants of India;* Dr. Waring, *Pharmacopœia of India;* and *The Glossary of Anglo-Indian Words*, by Sir H. Yule and Mr. H. C. Burnell.

BIBLIOGRAPHY.

Portuguese.

First edition printed at Goa, . .	1563,	pp. 217.
Second ,, ,, Lisbon, .	1872,	pp. xxix. and 258.

Latin.

An abridgment by Carolus de L'Ecluse (Carolus Clusius), Antwerp, Plantin, 1567 (pp. 280 and ind.). Subsequent editions appeared in the years 1574 (pp. 227 and ind.), 1579 (pp. 217 and ind.), 1582, 1584, 1593, 1595, and afterwards, in 1605 (or 6 ?), it was included in the folio *Clusii Exoticis*, with many plates (pp. 145–242). In 1572, Joa Tragoso, in a work published by Israel Sprach in Strasbourg, 1600, expressed his approval of Orta's work. In 1642 Jacob Bonsio published some observations on the book, in Latin.

Italian.

A translation from the Latin version was published by Annibal de Briganti (of Chieti) in 1576, which was followed by subsequent editions in 1582, 8vo (12mo ?), with many woodcuts, Venice, 1589 (or 4 ?), and 1616. An Italian version of A'Costa's compilation (see below) appeared at Venice in 1585. 4to.

Spanish.

The "Tractado" of Christophorus (Cristobal) A'Costa consisted of Clusius' abridgment of Garcia, together with A'Costa's own personal observations, made in India, on the plants. It was first printed at Burgos in 1578; a Latin translation by Clusius appeared in 1582, &c., as above.

DUTCH.

The travels of Linschoten, first published in 1596, with the additions by Paludanus (Bernard Ten Broeck), abound with extracts from Clusius' version of Garcia's work.

FRENCH.

An edition, founded on the text of Clusius, with some additional plates, was published in French by an apothecary named A. Colin, in 1609, which was followed, in 1619, by a 2nd edition, revised and augmented, Lyons, Pillehotte, 8vo, 369 pp., with a preface and index.

ENGLISH.

London, 1577. 4to.

In all these compilations and abstracts the alphabetical order of subjects and the dialogue form were abandoned.

INTRODUCTIONS AND DEDICATIONS, &c.

The introductory matter in the second, or 1872 edition, is somewhat copious, consisting, in the first place, of a dedication by the editor, F. A. de Varnhagen, addressed to the Imperial Academy of Medicine of Rio de Janeiro. This is followed by a preface containing a bibliographical sketch and an account of the original edition, in which, while the merit of the author is extolled, the defects in the printing of his work are pointed out. The colloquial form, and even the pagination of the original, are preserved and reproduced in this edition. Its preparation required much study upon the part of the editor, who, however, does not offer many notes in the way of elucidation, and, for reasons which he gives, has not inserted the botanical names of the plants which are mentioned. In order, however, to check Garcia's references to other authors—Greek, Latin, and Arab—he had to make himself acquainted with their works, and thus, while disclaiming acquaintance with Asiatic drugs, and avoiding the part of a critic of technical matters, he has laid a solid foundation for others to work upon. Following the preface, we find the "Dedication by the Author to the most illustrious Senhor Martim Affonso de Sousa," &c. &c. As the tender plant is protected by the strong tree, so Garcia asks him for protection for his treatise against the assaults of the envious.

A poetical dedication by the author is then given, followed by a poem by Camoens, who was at that time in Goa. It is addressed to Conde de Redondo, Viceroy of India. We next find a "To the Reader" by the Licentiate, Dimas Bosque, a Valentian Physician, who commends the research and stores of information in the work, and exhorts readers to give it a good reception, so that the friends of the author may be emboldened to urge him to occupy himself with a still greater undertaking. He says that the author commenced to write the work in Latin, but was prevailed upon to issue it in the more widely understood Portuguese, and mentions that he had adopted the colloquial style, as it enabled him to make references to subjects other than those connected with the drugs of India.

This is followed by a Latin dedication to Thoma Roderico, first physician of the Coimbre Academy, by Dimas Bosque, and a further dedication, in Latin verse, to the author, Dr. Garcia de Orta, by Thoma Caiado.

Contents of Part I.[1]

COLLOQUIES I.–XXX.

[1] This division of the 58 Colloquies into two Parts is merely a matter of present convenience for publication, as it does not exist in the book itself.

XIV. *Cassia*—Fruit of *Cassia fistula*, Linn.
XV. Cinnamon—The bark of *Cinnamomum zeylanicum*, Breyne, and other species.
XVI. (1) Cocoanut—The fruit of *Cocos nucifera*, Linn.
(2) Coco-de-mer—The fruit of *Lodoicea seychellarum*, Labill.
XVII. (1) *Kostus*—The root of *Aplotaxis auriculata*, D'C. (= *Aucklandia costus*, Falc.).
(2) Cholera.
XVIII. (1) Borax.
(2) Turmeric, *Croco Indiaco*)—The root of *Curcuma longa*, Linn.
(3) *Curcas*—Seed of *Jatropha curcas*, Linn. ?
XIX. *Cubebs*—Fruit of *Piper cubeba*, Linn.
XX. (1) *Datura*—Seeds, leaves, &c., *Datura stramonium*, Linn. and *D. alba*, Nees.
(2) *Durian*—Fruit of *Durio zibethinus*, D'C.
XXI. Ivory of the elephant.
XXII. (1) Areca—The nuts of *Areca catechu*, Linn.
(2) Plantain (Indian fig)—The fruit of *Musa sapientum*, Linn.
XXIII. *Malabathrum* (Indian leaf)—The leaves of *Cinnamomum tamala*, Fr. Nees.
XXIV. (1) *Galanga*, small, from China—The rhizomes of *Alpina officinarum*, Hance.
(2) *Galanga*, large, from Java—The rhizomes of *A. Galangal*, Willot.
XXV. Clove—Flowers of *Eugenia caryophyllata*, Thunb.
XXVI. Ginger—Root of *Zingiber officinale*, Roscoe.
XXVII. (1) *Coru* (*khaskurro*)—The bark and seeds of *Holarrhæna antidysenterica*, Wall.
(2) *Avacari*—? The root of *Sal*, *Shorea robusta*, Roxb.
(3) Sensitive plant.— *Mimosa pudica*, Linn.
XXVIII. (1) Jack. The fruit of *Artocarpus integrifolia*, Linn.
(2) *Jamboloes*—The fruit of *Eugenia jambolana*, Lam.
(3) *Jambos*—The fruit of *Jambosa Malaccensis*.
(4) *Jangomas*—The fruit of *Zizyphus sp.* ?
XXIX. Shellac—A secretion by the *Coccus lacca*.
XXX. Lignum aloes (Eagle wood)—wood of *Aquillaria agallocha*, Roxb.

COLLOQUY I.

PREAMBLE.

In which is introduced Doctor Ruano, well known to the author in Salamanca and Alcala, who came to India with a brother-in-law of his, a factor of a ship, and who came there for no other object than to obtain information regarding the medicines of that land and of all other simples found there. When he arrived at Goa, and hearing of the author's presence, both being known to one another, he went to lodge with him, declaring his object, to which the author replied:—

Orta. Since we have both practised in the profession which you have followed since we studied together, and which has brought you to India, it is but right that you should tell me of anything in which I may be able to help you, and to that end I will henceforth devote myself.

Ruano. You must know then that although I came here, because I have a share in the ship in which my brother-in-law came as factor, I could nevertheless have excused my coming by his. But, I had a great wish to know of the medicinal drugs (which in Portugal are called "*de botica*"), and other medicinal simples which are found here, and of all fruits, and of pepper, the names of all of which I should like to know in various languages. I should also like to know where they are obtained and what trees or plants bear them, and how the Indian physicians use them. I should also like to know about other plants and fruits of this land even if they are not medicinal, and of the customs of this land and of things which happen here, because they will be told truthfully, having been seen by you or by persons worthy of credence.

O. In all these things I shall help you and tell you the truth. But I fear the things I shall have to tell may not be worth note; for so learned a man, who knows so much in theory, nothing but uncommon things will content.

R. If they satisfy you they will satisfy me, and it may be that you, because you know them, do not value them, and I, because I do not, may esteem them highly, as is according to reason. And since certain physicians who went from hence to Spain could not give me any explanation of these things nor satisfy my understanding, I should warn you that our conversation must be recorded, and for this purpose I have prepared a book in which all the questions are written in alphabetical order.

O. Well, senhor, since your curiosity makes you desire to learn, I will tell you the little I know from to-morrow forward; but as our friendship is so great and so old, it must be under the protest that whatever may not be well said, you will, without adulation or flattery, point out to me, and upon these conditions I promise to serve you and tell you the little I know, and then I will tell you both of the things which I know well and those about which I have doubt, stating only the truth upon oath.

R. By this, as I say, I shall receive a great favour; and now, if it please you, we will go to rest: but I am not sure I shall be able to sleep on account of my anxiety to question you in the morning.

COLLOQUY II.

DO ALOES.

[Aloes—The inspissated juice of *Aloe socotrina*, Lam., *A. vulgaris*, Lam., *A. litoralis*, König., &c.]

Garcia gives the following names as synonyms for aloes:—*cebar* (*sibra or accibar*), Arab; *area* (*erio*), Gujarat; *catecomer*, Canarese; *acibar*, Spanish; *azevre*, Portuguese; *herva babosa*, Portuguese for the plant.

It grows in Cambay, Bengal, &c., but that of Socotra is the most esteemed; the prepared juice from the latter was easily distinguished by its uniform composition, and cost four times as much as the others.

The statement of Pliny[1] and Dioscorides,[2] that the best kind is from India, Garcia explains by saying that it was first taken to India from Socotra.

In this colloquy and frequently throughout, Garcia refers to the *Nizamoxa* and *Nizamaluco* as titles of the Deccan sovereigns; they stand respectively for *Nizam Shah* and *Nizam al mulk*. A full explanation of the use of these titles will be found in Col. Yule's *Glossary*, p. 830.

Garcia quotes the remarks upon this drug by Mesue, Matheus Silvatico, Serapion, Avicena, Rasis, Mathiolo Senense, Antonio Musa, &c., and mentions that the Persian, Arab, and Turkish physicians were well acquainted with the writings of Hippocrates, Dioscorides, Galen, Aristotle, Plato, and Pliny.

As to the virtues of the drug and its uses it would be impossible in this as in many cases which follow to present them in an abstract like the present.

Parenthetically Garcia explains that the *Romes* or *Rumes* differ from the *Turcos* by the fact that the former are the inhabitants of Constantinople and her empire, and that the latter are dwellers in Natolia. He adds that, according to Platina, when Constantine left Rome to the Pope, the privilege of calling it Rome was given to him, and the people were called *Romeos*, and continue to be so to this day.

[References.[3]—*Clusius* (Acosta), p. 11; *Linschoten*, II., p. 126; *Bontius* and *Piso*, lib. iv., p. 41; *Ainslie*, I., p. 8; *Fluckiger* and *Hanbury*, p. 616; *Khory*, p. 538.]

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[1] Plin. lib. xxvii., cap. 4.

[2] Diosc. lib. iii., cap. 4.

[3] For full titles see above, p. 383.

COLLOQUY III.

Do Ambre.

[Ambergris—The fæces of the Cachelot or Sperm whale, *Physeter macrocephalus*, Linn., which occurs abundantly in the Indian Ocean.]

Garcia introduces the *ambre* as a medicine of which it is better to have a quantity than to know where it grows. It is called by the Arabs, *ambar*, and by the Latins, *ambarum*, and by all other nations the same, or with slight variation. Regarding its origin he says:—"Some have said that it is the sperm of the whale, others affirm that it is the excrement of an animal of the sea, or the foam of the sea, and others that it was produced from a fountain which sprung up from the bottom of the sea, and this appears better and more conformable to truth." Avicena and Serapion say that it is produced in the sea just as a fungus is produced on rocks and trees; and that when the sea rolls tempestuously it casts up stones, and with them throws up the ambergris. When the east wind blew much of it was found on the coast of Africa, at Sofala, on the Comoro Islands, Emagoxa, and Mozambique; and when the west wind blew it was found abundantly on the Maldives. He speaks of beaks of birds being sometimes found in it. These were, no doubt, the beaks of cuttlefish swallowed by the whales.

[References.—*Linschoten*, II., pp. 92–94, 141, &c.; *Bontius and Piso*, lib. iv., p. 41; *Ainslie*, I., 15; *Khory*, p. 103.]

COLLOQUY IV.

Do Amomo.

[Round or cluster Cardamom—Fruit of *Amomum cardamomum*, Linn.?]

Amama, Arab; *pes columbinus*, Latin; *pe de pomba*, Portuguese.

The source of this drug was unknown to Garcia, though he identified a specimen of it by means of Dioscorides' drawings of simples, with the *pe de pomba* (pigeon's foot).

[In the *Pharmacographia* of Fluckiger and Hanbury the *amomum* of the ancients is identified as above, and is thus described: "round cardamoms are produced in small compact bunches. Each fruit is globular, $\frac{4}{10}$th to $\frac{7}{10}$th of an inch in diameter, marked with longitudinal furrows, and sometimes distinctly three-lobed. The pericarp is thin, fragile, somewhat hairy, of a buff colour, enclosing a three-lobed mass of seeds, which are mostly shrivelled as if the fruit had been gathered

unripe. The seeds, which have a general resemblance to those of the Malabar cardamom, have a strong camphoraceous aromatic taste." It is produced in Cambodia, Siam, Sumatra, and Java.]

It would appear from what Garcia says that it reached India through Turkey, Persia, or Arabia; but that its native habitat was quite unknown to him.

As a constituent of two famous composite medicines it was highly esteemed in India; these were called *triaga* and *metridado*, and the Nizam Shah told Garcia that he would give weight for weight in gold for a cask of the former, and a present of 2000 *pardaos*[1] to any man who tested it, and he would have kept his word, adds Garcia, "if the devil had not taken him away to the company of Mahomet."

This chapter concludes with a sneer at the apothecaries of Goa for their want of enterprise in not searching the Continent for such drugs as *herva cidreira, lingua d'vaca, fumus terræ, tamarisco,* and *espargos*, all of which he says occur there.

[References.—*Fluckiger and Hanbury*, p. 587.]

COLLOQUY V.

DO ANACARDO.

[Cashew nut—The fruit of *Anacardium occidentale*, Linn.]

Called *bolador* by the Arabs; *bybo* in India [*kâju* is now the common name in India]; *fava de Malacca* by the Portuguese.

Garcia says it was unknown to the Ancient Greeks. The modern Greek name was, however, derived from the heart-shaped nut.

The tree was abundant in Cananor, Calicut, Cambay, the Deccan, and other parts of India.

[The old writers who say it is poisonous were misinformed, as preparations of the green nut are given in asthma, and even eaten as pickle. After being dried it becomes caustic, and is administered in "king's evil."]

Garcia's account of this tree, and the uses of its fruit are not very satisfactory or complete. He seems to have been unaware that it was introduced into India by the Portuguese from Brazil. I do not find the native names which he gives for it in other authors.

[References.—*Clusius* (*Acosta*), pp. 43, 44; *Linschoten*, II., pp. 27, 29, 36; *Piso* "Mantissa Aromatica," p. 193, fig.; *Khory*, p. 230.]

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[1] The *pardao* was worth from 2*s*. to 2*s*. 6*d*.

COLLOQUY VI.

DA ARVORE TRISTE.

[Arbor tristis—*Nyctanthes arbor-tristis*, Linn.]

Called *parizataco* (*párataka* or *párajátaka*, Sansk.) at Goa, and *singadi* in Malay (*siuli* in Bengal).

The tree, according to Garcia, was introduced into Goa from Malacca, and is not indigenous to the jungles of India.

The flowers, which only blossom at night and fall at sunrise, were used for scent, and the orange-coloured tubes of the corolla for colouring food; but its scent was inferior to that of *fules* (i.e. *phul*, Hin. = flower) called *mogory* [which I take to be the flowers of *Jasminum sambac*, Ait., a plant which occurs commonly, both wild and cultivated, in India, and from which various drugs are extracted. These flowers are still called *moogree* (or *mugri*), and are regarded as being sacred to Vishnu].

Garcia does not attribute any medicinal properties to the *arbor tristis*. He relates as an example of the fables of paganism "that this tree was the daughter of a man, a great noble, called *Parizatico* (*Párajátaka*, Sansk.), that she fell in love with the sun, who, after converse, abandoned her for the love of another, that she killed herself and was burned (as the custom is in this land), and from the ashes grew this tree, whose flowers abhor the sun, and in his presence do not appear." He adds that Ovid was probably from these parts, as he composed fables in this manner.

Linschoten also devotes a chapter to this subject, and it has received attention from various early writers, as will be seen in the footnotes to Linschoten, where the fable just related is shown to be taken from the Vishnu *Puranas*.

[References.—*Clusius* (*Acosta*), p. 60; *Linschoten*, II., p. 58; *Bontius and Piso*, lib. iv., p. 49; *Khory*, p. 380.]

COLLOQUY VII.

(1) Do ALTIHT, ANJUDEN, ASSAFETIDA E DOCE E ODORATA; (2) ANIL.

(I.)—[The inspissated juice of *Narthex* (*Ferula*) *asa-fœtida*, Fale, &c.]

Altiht (*hilatita*, the *hiltit* of Edisi, a geographer who wrote in the 12th century), and *antite* of the Arabs. Also *imgu* and *imgara* (*hinga*) of the Indians. *Anjuden* or *angeidan* (*anguddna*) is the name applied (in India) to the tree from whence it is derived.

Garcia says asa-fœtida, was reported to reach India from Khorassan, through Hormuz, but was also grown in Gujarat, and from "Dely, a very cold land which on its further side borders on Khorassan and Chimam, as Avicena says." It also came from Mandu and Chitore.

He devotes a considerable space to the discussion of the etymology of the various names by which the drug was known to Orientals and Europeans. He identifies *laserpicium* with *asa-fœtida*, the fact that it was used as a condiment being a confirmation of this opinion. It was largely used by the natives with their vegetable food as a corrective, and considerable aphrodisiacal properties were (and are still) ascribed to it.

He says Avicena was from Bokara, and mentions many other authorities in this Colloquy. (See N°. II.)

[References.—*Bontius and Piso*, lib. iv., p. 41; *Ainslie*, I., p. 20; *Fluckiger and Hanbury*, p. 280; *Khory*, p. 336.]

(2) *Anil*, Arab and Turk, and *gali* and *nil* in Gujarat.

[Indigo.—*Indigofera tinctoria*, Linn.]

Garcia, though he enlightens his questioner as to the nature of *anil*, points out that it is not a medicine but an article of merchandise. He adds, that the herb which produces it is like that which they call *mangericão* (?) His short description of the manner of manufacture is not very correct. He remarks that indigo should have, when pure, the finest dark blue colour that can be.

It is tested, he says, by burning, when there should be no sand in the residue; it should also, when pure, float readily upon water.

[References.—*Linschoten*, I., p. 62; II., pp. 91, 230; *Ainslie*, I., p. 178; II., p. 33; *Khory*, p. 250.]

A question arising as to a fruit of the size of a walnut, Garcia says it is used as an appetiser, is green when fully ripe, has a cartilaginous rind, and is acid in flavour. It is called *ambares*. Probably the fruit of *Spondias mangifera*, Pers., if not, possibly that of *Emblica officinalis*, Gærtn.

[References.—*Clusius* (*Acosta*), p. 77; *Linschoten*, II., 24?]

COLLOQUY VIII.

Do Bangue.

[Indian Hemp.—*Bháng* or *báng*, *Cannabis sativa*, Linn.]

Garcia points out that *bhang* is not as supposed by Ruano the same as *amfio* (opium), and that though allied to *linho alcanave* (i.e. common hemp) it is distinct from it; he adds that the latter is abundant in the

Deccan and Bengal, as is also true flax, "of which our shirts are made."

The *bhang*, he says, is prepared from the pounded leaves, and sometimes from the seed, and some mix green areca with it, others add nutmeg and cloves, Bornean Camphor, ambergris, musk, or opium. This composition, when taken, makes the Moors, who use it, intoxicated, and variously affects different persons, some becoming witty or facetious, others sad and melancholy. It is supposed to be strongly aphrodisiac, and to increase the appetite. In this belief it is used by some of the Portuguese. Slaves and labourers found relief from their troubles by taking it. Linschoten's chapter on "*Bangue*" is almost verbally identical with that by Garcia.

[References.—*Clusius* (*Acosta*), p. 80; *Linschoten*, II., p. 115–117; *Ainslie*, II., p. 108; *Fluckiger and Hanbury*, p. 493; *Khory*, p. 502.]

COLLOQUY IX.

Do Benjuy.

[Benzoin—Gum Benjamin, the gum resin of *Styrax benzoin*, Dryander. The Siam variety is considered by some to be from a distinct species.]

Called commonly *cominham* (*kaminian*) by the Malays; *benjuy de boninas* was a superior variety, as also was *amendoado*, which had white almond-like patches in it, so named by the Portuguese; *louanjaoy* (*lubán Jáwi*, i. e. incense of Java) by the Moors, *udo* (*auda*) by the Deccanis and Gujaratis (*vrddha*, Sanskrit).

A large part of this colloquy is taken up with discussing the early references, or rather the supposed references to this resin. Garcia explains how it came to be confused with asa-fœtida, and shows that it was not produced in Judea or in Europe. It was a considerable export from India to Arabia, Turkey, and Persia.

The valuable *amendoado* variety, came, he says, from Siam and Martaban—the blacker kind came from Java and Sumatra; the *benjuy de boninas* (i.e. of flowers) also came from Sumatra, and was, he believed, obtained from new trees. Garcia suggests that storax was mixed with this variety. He mentions, parenthetically, in this colloquy that Ludovico Varthema was an author unworthy of credence.

[References.—*Linschoten*, I., pp. 102, 112; II., pp. 96–98; *Bontius and Piso*, lib. iv., p. 42; *Ainslie*, I., p. 33; *Fluckiger and Hanbury*, p. 361; *Khory*, p. 384. See also *Glossary* by Sir H. Yule for etymology and early notices.]

COLLOQUY X.

(1) Do Ber, que são as maçãs que ca usamos; (2) et dos Brindoes; (3) Dos nomes e apellidos dos reis e senhores destas terras; (4) do enxadrez e de suas peças; (5) e do Betre.

(1) *Do Ber.*

[*Bier*, the jujube, fruit of *Zizyphus jujuba*, var.]

Called *bor* by the Canarese; *ber* in the Deccan; *vidaras* of the Malays.

The best, says Garcia, are long shaped [the cultivated variety] from Balaghat, from a different tree from the *jujubas*, as is also a small kind brought from Khorassan. The *ber*, he adds, is much prized in Goa, as it there takes the place of the pippins of Portugal.

[References.—*Clusius* (*Acosta*), p. 24 (?); *Ainslie*, II., p. 94; *Khory*, p. 220.]

(2). *Dos Brindoes.*

[Called *Mate mangosteen* by the English in India, the fruit of *Garcinia purpurea*, Roxb.]

Of this fruit Garcia says:—" Outside it is somewhat red, but inside it is of a fine red which resembles blood; and there are some which are black, and these are not so sour, because this blackness comes through their being very ripe; but inside they are always very red, and although they are pleasant to the taste of many, they are not so to mine, neither for medicine nor as food because of their great sourness, the tamarind being more agreeable. This fruit serves for dyeing, and the rind is dried and exported by sea to make vinegar. Some persons have already taken it to Portugal, and succeeded well with it."

[References.—*Linschoten*, II., p. 34; *Khory*, p. 169.]

(3). *Dos nomes e apellidos*,[1] &c.

[i. e.—Names and titles of the kings and nobles of these regions.]

Garcia says that Nizamoxa (Nizam Shah) is the King of Balaghat, and that he himself had several times cured the Nizam, for which he received 12,000 *pardaos*, but had refused a yearly retainer of 40,000 *pardaos* to visit him at certain times in the year. He speaks of a King Dely (or king of the kingdom of Dely) who had taken Balaghat some

[1] Garcia says that it is only in deference to his questioner's special request, and for the information of people in Spain that he introduces a subject like this, that in no way serves the ends of physic.

300 years previously from the *Venezaras* (*Vanjárás* or *Brinjárás*), and the *Colles* (*Kolis*, whence Cooly) who, like the *Reisbutos* (Rajputs) live by thieving to this day, and are unsubdued, and receive blackmail from the kings in the vicinity of the regions occupied by them.

Although the remainder of this account contains much of interest it need not further be dealt with here, as it is all reproduced in Linschoten, chap. 27, and has been annotated in the recent edition of his travels, published by the Hakluyt Society (1885, vol. i., pp. 165–174). It is so confused and incorrect, however, that the editors remark that "it would take too much space to correct it fully." Garcia's historical information was evidently obtained from ignorant natives.

(4). *Do enxadrez e de suas peças.*

(Concerning chess and chessmen.)

Garcia says that in playing chess natives say *xa* (i.e. *shah*) or king, instead of *xeque* (*sheikh*) for our check. The queen they call *goazir* (*vazir*), the bishop, *fil* (i.e. elephant), the knight, *guora* (i.e. *ghora* = horse), which he incorrectly says also means elephant, the *roque* (our castle, *rook*) *roch ha*, and the pawn (*piada* and *peon* = a foot soldier).

COLLOQUY X. *bis.*

Do Betre.[1]

[Betel.—Leaves of *Chavica betel*, Mig.]

Betre in Malabari; *pam* (*pan*) in Deccani, Gujarati, and Canarese; *ciri* in Malaio (Borneo ?); *tembal* by Avicena.

Garcia says he never could overcome the dislike to betel which he experienced when he tasted it on his first arrival in India, though many Portuguese use it. It is eaten mixed with areca nut, lime, Bornean camphor, aloes, *kutch*, or catechu, and ambergris. He says the Nizam Shah expended 3000 *cruzados*[2] upon it annually, it being then (as now) presented at the conclusion of interviews.

He says the Indians are in the habit of keeping the nail of the right thumb pointed and sharp, in order to remove the midrib of the leaf. Betel was regarded as an aid to digestion, and a powerful aphrodisiac.

[1] This is put in the 1872 edition in its proper place, having been erroneously printed at the end in the original Goa edition, as is pointed out by the author himself.

[2] The *cruzado* was worth from 2*s*. 3*d*. to 2*s*. 10*d*.

Betel, he says, chiefly grows near the sea, but was also cultivated at Daulatabad and Bisnagua (Vijayanagar). He points out that it is quite distinct from the *Folium Indum* (*malabathrum*), *see* COLL. XXIII.

[References.—*Clusius* (*Acosta*), p. 23; *Linschoten*, II., pp. 53, 63, &c.; *Bontius and Piso*, lib. vi., p. 91, fig.; *Ainslie*, II., p. 269; *Fluckiger and Hanbury*, p. 607; *Khory*, p. 496, and *Yule's Glossary*, p. 67.]

COLLOQUY XI.

(I.) DO CALAMO ARAMATICO E DAS CACERAS. (2)

(1).—[Rhizomes of Sweet flag, *Acorus calamus*, Linn.]

It is called, according to Garcia, *vas* (*vája*) in Gujarat, *bache* (*bácha*) in the Deccan, *vasabu* in Malabar, *daringo* (*deringu*) in Malaya, *heger* (*eger*) in Persia, *vaicam* in Concan, *cassub aldirira* (= *qaçab al dha ira*) in Arabia.

Garcia maintains that it is only produced in India, in Gujarat and Balaghat, where it is largely cultivated, and is distinct from the *acorus* of Europe. He explains some of its topical names as being due to its having been imported into various places from India. He states that it is used as a medicine in India for diseases of men and women, and in the cold season it forms part of a compound called *arata*, which is given each morning to horses.

[According to Fluckiger and Hanbury the *acoron* of Dioscorides and Pliny is certainly identical with this, and probably also the *καλαμος ἀρωματικος* of Dioscorides. It is now established as a wild plant throughout the greater part ofEurope, and is cultivated in Burmah and Ceylon.]

[References.—*Linschoten*, II., p. 128 n; *Ainslie*, I., p. 417; *Fluckiger and Hanbury*, p. 613; *Khory*, 536.]

(2). *Das caceras.*

[Singhara Nut?—*Trapa bispinosa*, Roxb.]

[It seems probable that the *caceras* of Garcia is the nut known now in Bengal as the *singhárá*, but his account of it is not very explicit.] He says:—"It is nothing but a fruit which grows in the mud under the ground, and afterwards, in the dry season, it shoots up and sends up a stalk as short as the forefinger, with leaves joined one with

another, and these leaves are very green, and of the form of the *padana* (?), and after the mud dries it shoots out like potatoes, and when dry tastes like common chestnuts, and before it is dry its smell is bad, . . . it is not used as physic."

[These nuts are eaten by the poorer classes of natives, and are cultivated in swamps and tanks to a large extent in some parts of India. An interesting account of the cultivation in the N. W. Provinces is given by Col. Sleeman in his "Rambles," &c., vol. i., p. 101.]

[References.—*Khory*, p. 301.]

COLLOQUY XII.

(1) De Duas maneiras de Canfora; (2) e das Carambolas.

(i.)—[The two kinds of camphor—(1) Bornean camphor, from *Dryobalanops aromatica*, Gärtn.; (2) Chinese camphor, from *Cinnamomum camphora*, Fr. Nees.]

Called *capur* and *cafur* by the Arabs.

Garcia says that a pound of the Bornean camphor was worth a quintal of the Chinese. It was of four denominations, namely, *head* worth 80 *pardaos* the *quintal; breast*, 20; *legs*, 12; *foot*, 4 or 5. He correctly describes camphor as an exudation, not the pith of the wood, as some supposed it to be. He says it was not known to the Greeks (this is confirmed by Fluckiger and Hanbury). The Bornean kind came from Borneo, Bairros (i. e. Baros? in Sumatra, not in Malacca, as he says) and Pacem (i.e. Pasei, also in Sumatra). Of the Chinese kind most came not from Canton but from Chincheo (a port in Fuh-kien, a province of China); it was made by the Chinese into lozenges, and it was believed that in the manufacture a certain proportion of the Bornean camphor was used. The Chinese kind was volatile, but the Bornean was not so.

Garcia gives some particulars in this colloquy as to the wealth and value of the exports generally from China.

[References.—*Clusius* (*Acosta*), p. 14; *Linschoten*, i., pp. 112, 120; ii., pp. 67, 117, 118; *Ainslie*, i., p. 48; *Fluckiger and Hanbury*, p. 458; *Khory*, p. 175.]

(2) Das Carambolas.

[Carambola—Fruit of *Averrhoa carambola*, Linn.]

Called *carambola* in Malabar; *camariz* in Canara and the Deccan, and *balimba* in Malaya (Borneo? See note on page 415).

Garcia says it is given medicinally, in diet, in fevers, and that from the juice a collyrium is prepared for dimness of vision. Many people find the taste pleasant, especially of those called *agras doces*, on account of their great acidity. An agreeable conserve is made of them with sugar, and he was in the habit of ordering it instead of acetous syrup. He explains in this as well as in other colloquies that the names for various Indian products, which had been adopted by the Portuguese, were derived from those in use in Malabar, because it was on that coast, at Cochin and elsewhere, that they first established themselves in India.

[References.—*Clusius* (*Acosta*), p. 73 ; *Linschoten*, II., pp. 33, 34 ; *Bontius and Piso*, lib. vi., p. 102, fig. ; Drury, *Useful Plants*, p. 56.]

COLLOQUY XIII.

(I.)—DE DUAS MANEIRAS DE CARDAMOMO (2) E CARANDAS.

(I.)*—The two varieties of Cardamom, *Cardamomo maior e menor* [i.e. the great and little Cardamom].

[The fruit of *Elettaria cardamomum*, Maton.]

Names—*Caculla quebir* (i.e. *qaqolla kabir*), the large var., and *caculla ceguer* (*qaqolla çaghir*), the small var., Arab.; *etremelly* (*elattari*) in Malabar; *luçal* in Ceylon; *hil* and *elachi* by the Moors in Bengal, Gujarat, and the Deccan ; and *dore* by the Gentoos (Hindus) of the same regions.

Garcia maintains that neither the Greeks nor Romans knew this drug, which he deduces from the fact that the descriptions of cardamomum by Galen, Dioscorides, and Pliny, do not agree with its characters. He says it is sown like our peas, and the tallest kind is about a *covado* (cubit) in height, and the pods which hang from it contain from 10 to 20 grains. Both varieties, he states, are found in India; principally in Calicut as far as Cananor and other parts of Malabar, and in Java. An especially large kind, but less aromatic, was produced in Ceylon and was carried to Hormuz and Arabia as merchandise.

Its principal use, according to Garcia, was for chewing with betel, but it was also used in the manufacture of syrups.

This chapter is principally occupied with a discussion as to the confusion about this drug in the works of writers, both ancient and modern, whom Garcia criticises somewhat severely.

[References.—*Linschoten*, II., pp. 67, 86–88; *Bontius and Piso*, lib. vi., p. 126, figs.; *Ainslie*, I., pp. 52, 54; *Fluckiger and Hanbury*, p. 582; *Khory*, p. 519.]

(2).—Carandas.

[*Karanda*, Hin., fruit of *Carissa carandas*, Linn.]

Garcia says the "Carandas abounds on the Continent and in Balaguate (Balaghát). The trees are of the size of the arbutus, and the leaf also, and the flowers are many, and smell like woodbine when they are ripe. It is a very agreeable fruit, is black, and tastes like grapes; and there was a man who made wine of it, and it yielded good must, and probably if there had been sufficient of it it would have become good wine. At first this fruit is green and of the size of a nut with its shell, and is larger in Balaguate." When ripe it is eaten with milk and salt, and while green it is salted and eaten to produce appetite. "It is also preserved in vinegar and oil, to make *achar* (pickle). Similarly there are brought from Persia, and Arabia, green plums, and apples, and vine stalks, &c."

[References.—*Bontius and Piso*, lib. vi., p. 94, fig.; Drury, *Useful Plants*, p. 116; *Khory*, p. 391.]

COLLOQUY XIV.

Da Cassia Fistula.

[*Cassia fistula*, Linn., *Cathartocarpus fistula*, Pers.]

Hiraxamber (*and chiarsamdar* apud Avicena) Arab; *comdaca*, Malabar; *bavasinga*, Canara; *bavassingua* by the Brahmins of the Deccan; *gramalla* (*garamalo*) by the Moors of Gujarat and the Deccan. The tree is called *bao* in Canara.

The tree, Garcia says, is of the size of a pear-tree, and the leaves like those of the peach, the flowers being like those of the *genista* (i.e. brown *cytisus*). The pod (*canna* or cane) is from two to five palms long. It is found wild throughout India and at Cairo; but the best is from Cambay; possibly it is found in Malacca and in Sofala. In Cambay a *kandy* weight of it, of 522 *arretels*, could be purchased for 360 *reals*, or one *pardao*, whence Garcia considers the Portuguese to be more blest than the Spaniards, who get their sole supply from S. Domingo, where it had been introduced and flourished. In the

West Indies, he says, the pods were hollow and large. Its chief use was (and is at present) as yielding a mucilage which acts as a purge. Garcia discusses various fabulous attributes given to the shells of the pod and other parts of the tree.

[References.—*Clusius* (*Acosta*), p. 41; *Linschoten*, II., pp. 121, 122; *Bontius and Piso*, lib. vi., p. 101, fig.; *Ainslie*, I., p. 60; *Fluckiger and Hanbury*, p. 195; *Khory*, p. 247.]

COLLOQUY XV.

DA CANELA E DA CASSIA LIGNEA E DO CINAMOMO.

[Cinnamon.—The bark of *Cinnamom zeylanicum*, Breyne, and other species.] Called *salihacha* by the Arabs and Persians; *quer fa* (the canela), by the Arabs; *darchini* in Hormuz; *caismanis* and *caismao*, Malaya; *cuurdo* (*kurundo*) in Ceylon; *camea* in Malabar.

Garcia says all the above are one and the same, though bearing different names, conferred by people at a distance who did not understand their nature properly, and were misled by differences in appearance and quality. He dismisses contemptuously the fables told about cinnamon by Pliny and Herodotus. He also disposes of the myth of its being derived from Ethiopia, saying that in early times it was carried by the Chinese (the *cassia lignea* from China) to Hormuz; and those who took it thence to Aleppo misinformed the Greeks as to its true source. Parenthetically he remarks on the diversity produced in fruits, not only by grafting, but also by transplanting from one country to another.

He speaks of the China trade which had existed with Ceylon, Malacca, and Hormuz, as many as 400 junks having, it is recorded, arrived in a single tide at Hormuz. He mentions a fort called *China cota* at Calicut, erected by the Chinese, and of a memorial stone left by them at Cochin.

The name cinnamon he derives from *amomo* (*cardamom*) of China, and cassia from *caismanis* (*kaimanis*). This long colloquy contains much information, and concludes with a picturesque description of Ceylon.

[References.—*Clusius* (*Acosta*), p. 22; *Linschoten*, II., p. 76; *Piso in Mantissa Aromatica*, p. 165, fig.; *Ainslie*, I., p. 72; *Fluckiger and Hanbury*, p. 466; *Khory*, p. 472.]

COLLOQUY XVI.

(1) Do Coco Comum; (2) e do das Maldivas.

[Concerning the common cocoa-nut and that of the Maldives (should be of the Seychelles.)]

(1)—The cocoa-nut, *Cocos nucifera*, Linn.

It is known by the following names; *maro*, the tree, and *narel* (*nariyala*) the fruit: names used by all as well as the Persians and Arabs; *jausialindi* (*jarije al Indi*, i.e. nut of India), so called by Avicena; *jar-al-nare* (i.e. tree of the coco), so called by Serapion and Rasis; *temgamaram* the tree, *temga* the fruit, by the Malabaris; *tricam* the tree, *nihor* the fruit, in Malacca; *Coco* by the Portuguese, because the fruit with its three scars resembles the face of the "*bogio*" or other animal.

This palm thrives best in sandy soil, especially near habitations, and is not found far in the interior. Parenthetically he remarks that the palmeira (i.e. *Barassus flabelliformis*) was unknown to the Greeks, and that the Arabs wrote little about it.

The timber of the Coco palm, though not very good, is useful on account of its great length. In the Maldives vessels are wholly constructed and fitted of materials furnished by the palm. In Malabar houses are thatched with the leaves, called *olla* by the Portuguese. There are two varieties of the palm, one yielding fruits and the other *sura* (i.e. toddy), which when fermented, they call *orraca* (*arrack*) and the finer quality which resembles brandy they call *fula* (from *phul* a flower). By mixing the *orraca* with a small quantity of *sura*, and placing it in the sun they make vinegar. After the *sura* they draw from the tree a further fluid from which, when thickened by sun or fire heat they make *jagra* (i.e. *jaggary* = molasses). The best kind is from the Maldives, being not so black as that from other countries. When fresh the fruit has a tender rind which tastes like the artichoke, a languid and sweet kernel, and a soft and sweet water. In its green state it is called *elevi* by the Malabaris, and *lanha* in Goa. The fibre of the husk is called *cairo* (*koir*) and is used for cordage and caulking vessels, as it does not rot in sea water. The shells are used as cups by the meaner sort of people, and the charcoal made by burning them is used by goldsmiths. Of the pounded fruit, with the milk, they prepare a dish which resembles rice and goat's milk. From the dried fruit called *copra* (*khopra*) they extract oil by means of a press, and they use it

both in food and for burning. Another kind of oil is made from fresh cocoa-nuts by pounding and pouringwarm water on them. This yields a purgative medicine, and the *copra* oil is good for the nerves, the patient being placed in a bath of it in a wooden trough. Garcia explains in a manner unlike his usual style the relaxing character of the oil as compared with the constipating character of the fruit, by saying that the former is formed of air, and the latter from the earth. The young sprouts constitute an agreeable vegetable which tastes like chestnuts.

[References.—*Clusius* (*Acosta*), p. 35; *Linschoten*, II., pp. 43, 51; *Bontius and Piso*, lib. IV., p. 45; *Ainslie*, I., p. 77; *Fluckiger and Hanbury*, p. 655; *Khory*, p. 555.]

(2) [The Coco de mer, *Lodoicea seychellarum*, Labill.]

To it many medicinal virtues were attributed by the older writers, including its being an antidote to poison. According to Garcia it was thrown up on the shores of the Maldives. He states that—"The common report is that these islands were once part of the Continent, and being low, they were inundated and these palms remained there rooted in the soil now covered by the sea, and being very old they produced these large Cocos. They have neither leaves nor trunk from which to judge whether they are of the same species (as the common) or not."

This description clearly refers to the *Coco de mer* of the Seychelles, the nuts of which are drifted eastwards to the Maldives, and have given rise to much speculation and myth since the earliest times. Of their reputed virtues Garcia is most incredulous.

[References.—*Linschoten*, I., p. 75; *Piso in Mantissa Aromatica*, pp. 203–226 (an elaborate disquisition); *Ainslie*, II., p. 127; *Khory*, p. 533.]

COLLOQUY XVII.

(1) DO COSTO (2) E DA COLLERICO PASSIO.

[(1) Kostos—The root of *Aplotaxis auriculata*, D'C. *Aucklandia costus*, Falc.]

Names—*Cost* or *cast*, Arabic; *uplot* in Gujarat; *pucho* in Malacca (the common name in India at present is *pachak*).

The *costus* grows in the region between Bengal, Delhi, and Cambay, i.e. the land of the Mandou (Mandu), and it comes also from Chitore, from whence come waggons laden with this *uplot* or *costus*,

despique (spikenard), and *tincar* (borax), to Amadabar (Ahmadábád), and Cambaiete (Cambay) whence, it is exported throughout Asia to Europe and parts of Africa. Garcia maintains that there was but one kind, and that it was only produced in India notwithstanding that writers have described varieties as though they came from Syria and Arabia.

In describing the Chinese, of whom he gives an excellent character, Garcia says that "the art of printing was always in use there, and it is not in the memory of man among them by whom it was invented," to which Ruano replies that the inventor was from Hungary, or the country to the north which is said to border upon China.

[References.—*Linschoten*, II., pp. 129–130; *Bontius and Piso*, lib. iv., p. 46; *Ainslie*, I., p. 167; II., p. 165.

(2) Cholerico Passio [Cholera].

Called *morxi* in India, corruptly *mordexi* by the Portuguese; *hachaiza* by the Arabs; *saida*, according to Rasis.

Garcia says that those attacked seldom survive twenty-four hours. A patient whom they visited was prescribed for as follows:—To get no water to drink, or, if any, some in which heated gold had been quenched; to have his feet cauterized with hot irons, and an emetic and a clyster administered, his body to be anointed with warm oil; and to drink chicken broth flavoured with cinnamon, rose water, coral, and gold. Garcia does not record whether the patient survived this treatment.

Other drugs which he mentions as being of specific efficacy in cholera are *bezoar*, *triaga*, *sumac*, &c.

[References.—*Linschoten*, I., pp. 235, 236; II., p. 22; *Bontius and Piso*, lib. ii., p. 21; *Ainslie*, I., pp. 82, 93, 304; II., p. 531; *Khory*, pp. 106, 239, 280.]

COLLOQUY XVIII.

(1) Da crisocola (2) e croco Indiaco (que e açafrao da India) (3) e das curcas.

(1) Crisocola (or Borax).

Garcia says it is called *tincar* in Arabic (the Arab name is *buruk* or *boraga*, and *tinkara* or *tankara* the Persian; it is called *tinkal* in India).

Garcia says borax is little used in India for medicinal purposes, but for the teeth and in the cure of the itch and in surgery it is employed

to some extent. As an article of merchandise it comes from Mandu and Chitore, being obtained in a mountain 100 leagues from Cambay (it was really obtained from Thibet, which is more distant). It was used largely as a flux for melting gold and other metals.

[References.—*Ainslie*, I., p. 44; *Khory*, p. 79.]

(2) *Croco Indiaco, açafrao da terra* or *açafrao da India.*

[Turmeric, the root of *Curcuma longa*, Linn., and other species.]

Called *alad* (*halada* or *haladi*) or *mangale* (*munjel*) by the Canarese and Malabarese; *cunhet* (?) by the Malays; *dazard* (*dára-zarda*) by the Persians; *habet* (?) by the Arabs. It is the *calidunium* or *caletfium* of Avicena.

Garcia says it is not found in Persia, Arabia, or Turkey, but was abundant in Cananor and Calicut.

It was used in India, and also in Arabia and Persia for dyeing and for seasoning. It was also applied to sore eyes, and, mixed with orange juice and cocoa milk, it was efficacious for the itch.

[References.—*Clusius* (*Acosta*), p. 48; *Bontius and Piso*, lib. vi., p. 116, fig.; *Ainslie*, I., p. 454; *Fluckiger and Hanbury*, p. 577; *Khory*, p. 521.]

(3) [*Das Curcas.* Seeds of *Jatropha curcas*, Linn. ?]

Called *curcas* and *chiviquilengas* in Malabar; *carpata* in Cambay; *hab-al-culcut* of Serapion; *quilquil* of Rasis.

Garcia describes *curcas* as consisting of certain white grains larger than a hazel-nut with a shell, but not so round, and tasting like cooked truffles. They were cultivated in Malabar, and grow in clusters. If taken in quantity they are apt to cause cholera, and are aphrodisiac.

[I have very much doubt as to the identity of this fruit, because *Jatropha* is said to be poisonous and to produce violent purging; but Garcia appears to have used his *curcas* in curry, and says that it was non-medicinal, while Ainslie and Khory ascribe to the *Jatropha* medicinal properties.]

[References.—*Ainslie*, II., p. 45; *Khory*, p. 490.]

COLLOQUY XIX.

Das Cubebas.

[Cubebs—The fruit of *Piper cubeba*, Linn. A climbing diœcious shrub, indigenous to Java, Southern Borneo, and Sumatra.]

Names—*cubeb* and *cabeb* by the Arabs; *cabebechini* (*kababa chini*) by people in India generally except those who speak Malay, because it was brought to India from Java by the Chinese; *cumac* or *cumacos* in Java.

It was used by the Mahommedans in India, as an aphrodisiac. It grows like the pepper, but its leaves are somewhat narrower than those of the pepper. The fruit is cooked before exportation to prevent its cultivation elsewhere. Garcia points out that it was a mistake to confound it with *pimenta*, which was also exported from Sunda, but in much larger quantities; being used as an article of food not a medicine. He further states that Serapion and Avicena were in error in regarding cubebs to be the same as the *carpessio* of Galen, and the *myrto agreste* of Dioscorides. He also denies that it is to be identified with the *vitex* or *agnus castus*, the latter being an aphrodisiac.

[References.—*Linschoten* II., p. 130; *Ainslie* I., p. 98; *Fluckiger and Hanbury*, p. 526; *Khory*, p. 494.]

COLLOQUY XX.

(1) Do Datura (2) e dos Dorioes.

(1.) *Datura.*

[The Datura plant, *Datura stramonium*, Linn., and *D. alba*, Nees.]

Garcia describes the intoxicating effects produced by *datura*, and takes Ruano to see a woman under the influence of a dose administered by her servant previous to robbing her. He prescribes for the woman emetics, clysters, and bleeding, and says this treatment never fails.

[References.—*Clusius* (*Acosta*) p. 77; *Linschoten*, I., pp. 210, 211; II., pp. 68, 72, 212; *Ainslie*, I., pp. 443, 446; *Fluckiger and Hanbury*, p. 412; *Khory*, p. 451.]

(2) *Dorioes.*

[The Durian fruit, *Durio zibethinus*, D'C.]

Garcia's account of this famous fruit resembles those now often recorded which represent it as most agreeable to some and repulsive to others. Some persons are infatuated about it, while others, he says, describe it as suggestive of rotten onions. The Malays regard it as an aphrodisiac.

[References.—*Clusius* (*Acosta*), p. 65; *Linschoten*, ii., p. 34; *Bontius and Piso*, lib. vi., p. 118, fig.]

COLLOQUY XXI.

Do ebur ou marfim e do elefante.

[Ivory and Elephants.]

Called *fil* by the Arabs; *ati* by the Deccanis; *aceti* by the Canarese; *ane* by the Malabars; *ytembo* by the Caffres of Ethiopia.

Garcia denies that the bones of elephants are used for any useful purpose. He states, with less than his usual accuracy, that the elephant has only two teeth (by which perhaps he meant tusks, ignoring altogether the molars), and relates a story of an elephant in Malabar, which not only could speak two words, but that when ordered by its *naire* (*nair*), keeper, to take a kettle to be mended, observing that on the first occasion it was done imperfectly, on the second it, of its own accord, tested for leaks by dipping the kettle in water.

Six thousand *quintals* of ivory were imported into India annually from Sofala and Melinda in Ethiopia. There were a few elephants in Malabar, many in Ceylon, and the latter were considered the best in India. Elephants were also to be found in Orissa, Bengal, and Patna, and on the borders of the Deccan (Cotamulco)—i.e. the *mulk* (country) of Qutab—in Pegu, Martaban, and Siam. Garcia seems to be doubtful as to the existence of a white elephant in Siam, and that the king was called "lord of the white elephant." Cambay alone consumed nearly the whole of the six thousand *quintals* of ivory brought from Africa, this being due to the fact, as Garcia puts it, that "the demon infuses a certain superstition into the women and girls of the Banyans, who are those that live according to the Pythagorean custom. It is, that when any relative dies the women burn all the bracelets on their arms, which are twenty at least, and then they make other new ones, &c."

He concludes by saying that there are more elephants in Africa than there are cows in Europe. He describes the method of their domestication and capture in India, and their use in war; and he combats the common but erroneous idea as to the mode of their sexual intercourse, adding, as others have done since, that the male generally takes advantage of higher ground at the time, the female standing below. He confirms Pliny's account of the superiority of the elephants of *Taprobana*, provided he meant Ceylon, and not Sumatra, thereby. The training was effected by whips, abuse, and hunger, combined with kindness and good treatment.

[References.—*Clusius* (*Acosta*), p. 17; *Linschoten*, p. 1; *Ainslie*, II., p. 479; *Khory*, p. 101.]

COLLOQUY XXII.

(1) Do Faufel (2) e dos Figos da India.

(1) *Faufel*—The nuts of *Areca catechu*, Linn.

Called *faufel* and *filfel* (*fofal*) by the Arabs; *pac* (*paak*) in Malabar; *areca* by the Nairs; *supári* by the Gujaratis and Deccanis; *chacani*, a small variety in Cochin; *pina* (*penang*) in Malacca; *poas* (*puwák*) in Ceylon; *areca* and *avelam da India* by the Portuguese.

Garcia describes the use of areca as a masticatory when combined with *cati* (*cutch*), lime and the leaf of the *betel*, and where the latter is not obtainable cloves are substituted. A good kind is found at Chaul, but the best was from the Island of Mombain (Bombay, *see* Coll. xxxiv.), which, he adds, was leased to him by the King of Portugal. He says, that the tree was only found in two parts of Arabia, namely, Xael (Shael or Zeyla in Africa) and Dofar (Darfur). He says that the nut, if eaten when green, causes intoxication. Eaten with the betel, &c., it purges the head and stomach, and comforts the gums and teeth. The nobility add camphor, eagle wood (*see* Coll. xxx.), and ambergris to the other ingredients. He says he used distilled infusion of areca with success in choleraic diarrhœa.

[References.—*Clusius* (*Acosta*), p. 34; *Linschoten*, I., pp. 213, 214; II., pp. 62, 68; *Bontius and Piso*, lib. vi., p. 90, fig.; *Ainslie*, II., p. 268; *Fluckiger and Hanbury*, p. 607; *Khory*, p. 531.]

(2) *Dos figos da India*—Indian figs.

[The Plantain, *Musa sapientum*, Linn.]

The above title for the plantain is commonly used by early writers

on India. The Portuguese appear to have derived the name from that in use by the Mahommedans, who regard the plant as having furnished the leaves with which Adam and Eve clothed themselves in the Garden of Eden.

Garcia states that the native names are *queli* in the Deccan, Gujarat, and Bengal; *palam* in Malabar; *piçam* in Malaya (Borneo?); *musa* and *amusa* by the Arabs; *bananas* in Guinea; *ininga* by the Caffres.

Garcia quotes Avicena,[1] Rasis,[2] and Serapion[3] on the therapeutic qualities of the fruit. It is, they say, an aphrodisiac; but possessing little nutriment, it lies heavy on the stomach. It may be applied with advantage to the lungs and breast to reduce inflammation. He commends a dish of them when roasted, steeped in wine, and sprinkled with cinnamon.

A well-flavoured variety, green and long, from Malabar, is, he says, called *chicapaloes*. He refers to it being found in Brazil, and being cultivated in Portugal.

[References.—*Clusius* (*Acosta*), p. 67; *Linschoten*, II., p. 37; *Ainslie*, I., p. 316.]

COLLOQUY XXIII.

Do folio Indio ou folha da India.

[Of Malabathrum, leaves of *Cinnamomum tamala*, Fr. Nees.]

Called *tamalapatra* in India; *cadegi Indu* (*sadaj-i-Hindi*) Arab; *malabatrum* of Greeks and Latins[4]; *lingua de vaca*, *lingua de passaro*, and *melao da India* are mere translations of the Arabic name.

He says the accounts by Pliny and Dioscorides are incorrect as to the plant being like a water bean, for these leaves are borne on a tree (which is quite true). He denies that it grows in marshes, and states that it occurs on dry land. It is not found, he adds, in Abyssinia, and doubts its occurrence in Egypt and Syria. It was said to have the same qualities as spikenard, was useful as a diuretic, and for preserving clothes from moths, &c.

[References.—*Linschoten*, II., p. 131; *Fluckiger and Hanbury*, p. 480; *Khory*, p. 472.]

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[1] Cap. 492, lib. ii. [2] Ad Almansorem, cap. 3. [3] Cap. 84.
[4] Dioscorides, lib. i., cap. 2, Galen's, *Simplicium medicamentorum*.

COLLOQUY XXIV.

De duas Maneiras de Galanga.

[Of the two kinds of *galanga*, the rhizomes of *Alpina officinarum*, Hance, and *A. galangal*, Willd, the former is the small kind and is from China, and the latter, the large kind, is from Java.]

Called *calvegião* by the Arabs (should be *khalandján*); *chaligao* and *gàlungem* by the Moors after Serapion;[1] *lavandon* by the Chinese for their species, and *lancuas* by the Javanese for theirs. The Indians and Portuguese apply the last name, *lancuas*, to both varieties.

Garcia describes the Chinese species as having leaves like the myrtle (which is incorrect, both being flag-like plants with lanceolate leaves). They are propagated by their roots like ginger, though occasionally grown from the seeds by the Javanese residing in India, who used the plants in salads and for medicine. He says it is quite different from the *Calamo aromatico* and *acoro* (*see* Coll. xi.), is hotter, and has a sweeter smell, and is not applicable to the same purposes. He adds that it is a mistake of the Italian friars to identify it with *esquinanto* (*see* Coll. lii.), which grows in Arabia.

[References.—*Clusius* (*Acosta*), p. 48; *Linschoten*, ii., p. 131; *Piso, Mantissa Aromatica*, p. 191; *Ainslie*, i., p. 140; ii., p. 146; *Fluckiger and Hanbury*, p. 580; *Khory*, p. 524.]

COLLOQUY XXV.

Do Cravo.

[Of the Clove—Flowers of *Eugenia caryophyllata*, Thunb.]

Called *gariofilo*, or more properly, says Garcia, *cariofilo* by the Latins (*caryophyllium*); *calafur* (should be *quaranfol*) by the Arabs, Persians, Turks, and most of the Indians; *chanque* (should be *chenkeh*) in the Moluccas.

Garcia (incorrectly) says it was a recent discovery unknown to the Greeks, and not mentioned in Galen's original works, though occurring in later editions. He refers to the Molucca Islands as having been the cause of war between the Spanish and Portuguese. He says the trees resemble the laurel in size, and that though they grew in Ceylon

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[1] Cap. 332. Further on he says, Serapion described the two species under the names *calumgiam*, c. 331, and *cazerhender*, c. 196.

they bore no fruit there, being only productive in the Moluccas.[1] There are two varieties, the smaller of which is pulled and dried when formed, and the larger, called *Madre do cravo*, is allowed to ripen on the tree. The stalks of the flower-heads are called *fuste* by the Spanish, and *castum* by the Portuguese. Called *cravo* because it is in the form of a nail. The tree takes eight years to mature, and lasts, it is said, 100 years. The crop is gathered from the middle of September to January, and into February. The inhabitants of the Moluccas do not themselves use it. It was first made known by Chinese traders to India, Persia, and Arabia.

[References.—*Clusius* (*Acosta*), p. 31, fig.; *Linschoten*, pp. 67–81; *Piso, Mantissa Aromatica*, pp. 177, 179, figs.; *Ainslie*, p. 75; *Fluckiger and Hanbury*, p. 249; *Khory*, p. 308.

COLLOQUY XXVI.

DO GENGIVRE.

[Of Ginger—The root of *Zingiber officinale*, Roscoe.]

Called *gengibil* (*zangebilarataba*) by the Arabs, Persians, and Turks; *adrac* (*adraka*) when green, and *sucte* when dry by the Gujaratis, Deccanis, and Bengalis; *imgi* by the Malabars; *alia* in Malaya (Borneo ?).

Garcia says that it is a plant like the flag or marsh-lily, &c. A variety cultivated at Baçaim (Bassein) is less pungent than the ordinary kind, the land there being more humid. Largely used in food, it is chiefly cultivated in Malabar, which kind the Persians and Arabs prefer; but it also comes from Dabul and Bengal, besides Bassein and other places along the Western Coast; but there is very little in the interior. It is also found in the Comoro Islands and Madagascar, and in Troglodita and Ethiopia, but not in Arabia. It is collected in December and January, and is covered with clay to stop the pores and preserve it from rotting and being attacked by worms. Garcia points out many mistakes in the descriptions of this plant by Dioscorides, Serapion, Mesue, &c.

[References.—*Clusius* (*Acosta*), p. 50; *Piso, Mantissa Aromatica*, p. 189, fig.; *Ainslie*, I., p. 152; *Fluckiger and Hanbury*, p. 574; *Khory*, p. 518.]

[1] Though originally only indigenous to the five islands of the Molucca Group, it is now found in Amboyna, Sumatra, Penang, Malacca, Mascarene Islands, Zanzibar, Pemba Island, and the West Indies. See *Fluckiger and Hanbury*, "Pharmacographia," p. 260.

COLLOQUY XXVII.

De duas Maneiras de hervas, &c.

[Of the two kinds of herbs used for fluxes, the names of which are given in this colloquy, and of a herb which will not allow itself to be touched without withering.]

(1) [The bark and seeds of *Holarrhena antidysenterica*, Wall.[1] A well-known shrub in Indian jungles.]

Called *coru* (*khao kurro*) by the Canarins (Kanarese); *herva do Malavar* by the Portuguese. (*kutaja*, Sansk.; *kureya*, Hind.; *kurachi*, Beng.)

A distilled preparation of the powdered bark of the root was a remedy for cholera. Garcia sets forth in some detail the treatment of diarrhœa, &c., with this drug, by the Portuguese, and describes the rougher preparation of it by the natives; the latter, he says, proving the more effectual of the two. He mentions also that the natives sometimes added opium and nutmeg. The drug was also used in medicines for vomiting and for weakness of the stomach.

[References.—*Clusius* (*Acosta*), p. 29; *Ainslie*, I., p. 88; *Khory*, p. 37.]

(2) *Avacari.*

[The information given about this plant is too slight for certain identification, but I venture to suggest that it may be *asva karana*, Sansk., namely, the *sal*, *Shorea robusta*, Roxb.[1]]

Garcia says that from the root of this plant a drug was prepared which was very efficacious in diarrhœa of old standing.

(The resin of the *sal* is recognized as a detergent and astringent by native practitioners.)

[Reference.—*Khory*, p. 177.]

(3) The herb which will not allow itself to be touched without withering.

(The sensitive plant—*Mimosa pudica*, Linn.)

Garcia simply describes the well-known property of this plant, adding that it is not medicinal.

[References.—*Clusius* (*Acosta*), p. 81; *Linschoten*, II., p. 70; *Bontius and Piso*, lib. vi., p. 119, fig.].

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[1] *Waring*, pp. 138, 455, has some important notes on the subject of the botanical history of this plant.

COLLOQUY XXVIII.

(1) Do Jaca, (2) e dos Jamboloes, (3) e dos Jambos, (4) e das Jamgomas.

(1) [The Jack fruit.—*Artocarpus integrifolia*, Linn.]

Called *jacas* by the Malabaris; *panas* in Gujarat.

Garcia describes this well-known fruit, and describes its peculiar habit of growing from the trunks of the trees, not from the branches; he compares the seeds to chestnuts, and says they are roasted for eating. Like the fruit they are somewhat indigestible.

[References.—*Clusius* (*Acosta*), p. 64; *Linschoten*, II., pp. 20–23, 36, 51; *Piso*, *Mantissa Aromatica*, p. 191, fig.]

(2) [*Jamboloes* — ? *Jambulá*, Gujarati—this is probably *Eugenia jambolana*. Lam = *Syzigium jambolanum*, Dec.]

Garcia's description of the plant is not quite clear enough to enable one to be certain of its identity, but it is probably a wild variety of the above. He says it is found in the fields, looks like the myrtle, and that its leaves resemble the arbutus. Ruano compared the fruit to Cordova olives in taste.

[References.—*Clusius* (*Acosta*), p. 75; *Linschoten*, II., p. 34; *Ainslie*, II., p. 444; *Khory*, p. 306.]

(3) *Jambos.*

[Rose apple—this is probably the *Malaka jamrul* of the Bengalis; *Jambosa Malaccensis.*]

Garcia describes the tree yielding these fruits as resembling the myrtle; and he says it had been recently introduced from Malacca. The fruit was the size of a goose's egg, red and white coloured, like large gall-nuts, but agreeable to the smell and taste. The tree bears a succession of fruits during the year, and the roots penetrate deep into the soil.

[References.—*Clusius* (*Acosta*), p. 74; *Linschoten*, II., p. 29; *Khory*, p. 306.]

(4) *Jangomas.*

Zizyphus sp. ?

Garcia describes this as a thorny tree, like a plum in shape and leaf, and that it grows wild in the country, but is transplanted. It

has white flowers; and the fruit is like small *sorva*, with a plum-like styptic flavour.

This description corresponds with that of the species of *Zizyphus* with one of which I think it may be identified—except that in Linschoten's account it is said they have no stone but some small kernels which resemble pistachios—the species of *Zizyphus*, however, have a stone which includes the kernel.[1]

[References.—*Clusius* (*Acosta*), p. 76; *Linschoten*, II., p. 32; *Bontius and Piso*, lib. vi., p. 111, fig.; *Ainslie*, II., p. 69; *Khory*, p. 220.]

COLLOQUY XXIX.

Do Lacre.

[Lac, *i.e.* shellac, an exudation produced on various trees by the *Coccus lacca.*]

Called *locsumutri* by the Arabs, Persians, and Turks, because it was shipped to Hormuz by the Chinese from Sumatra, though produced in Pegu; *treo* in Pegu and Martaban, and *lac* in Bengal, Balaghat, and Malabar.

It also came from 'Jamay' (that is, Laos in Siam); but Garcia says it was not produced in Sumatra. Garcia says he was informed that it was produced on trees resembling the plum by large ants which form it on the small branches, working as the bee works when making honey. He says he saw in Goa a branch of the *maceira* or *ber* which was covered with it. [This I take to have been the *Zizyphus* or *Jangomas* of the previous colloquy. The *Zizyphus jujuba* is one of the trees on which *lac* is obtained.] Garcia's account of the *lac* of Pegu, as being formed by the ants and being sometimes impure, was owing to the presence of the woody matter of the twigs round which it is concreted; it has doubtless given rise to the somewhat exaggerated accounts to be found in subsequent writers.[2]

Garcia dispels certain erroneous ideas supposed to be held by Avicena, Dioscorides, Serapion, and others of the early writers as to the origin and affinities of *lac*. What they described were various gums, such as *caucamo* and *benzoin* (*see* Coll. ix.).

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[1] Curiously enough in the following chapter mention is made of the *maceira* or *ber* of the Deccanis, to which Garcia says he has made mention above (*see* Coll. x.).

[2] *See* Tavernier, English trans. by V. Ball, vol. ii., pp. 20 and 282.

He says that *lao* is used medicinally in India, and refers to the dye produced from it, or rather it should be which is separated from it. Owing to the discovery, by a dyer in Aleppo, of a tree which yielded a red dye, the trade in *lac* from India to Hormuz fell off very considerably. Ruano suggests that this dye was *gram* (?), which is also found in Spain and elsewhere.

[References.—*Clusius* (*Acosta*), p. 13; *Linschoten*, II., p. 88; *Bontius and Piso*, lib. iv., p. 42; *Ainslie*, I., p. 188; *Khory*, p. 112.]

COLLOQUY XXX.

Do Linaloes.

[Lignum aloes—Eagle wood, &c., *Aquilaria agallocha*, Roxb.]

Called *xilaloes*, cap. 742, and *agalugem*, cap. 14, by Avicena; *agalugem* and *haud* (*uda aghalu khi*) by the Arabs; *ud* by the Gujaratis and Deccanis; *garro* by the Malays (Borneans ?); and *calambac*, the best kind *agalveo* (*linho Indico*) of Paulo.

The true linaloes was, he says, obtained in Sumatra and Malaia (Borneo ?). A pseudo wood was called by the Portuguese *aquila brava;* and *alcomeri*, and *alsificasi*, names given by writers, signified that it came from Cape Comorin and Ceylon—was used for burning the dead bodies of the Banians. Catai (i.e. Canton), and Seni (Chincheo), where other writers said it came from, were ports of shipment for it, but not the real places of its production.

He says that it does not smell well till the outer bark is removed and the heart laid bare; but for this purpose it is not necessary to let it rot in the ground. The best is very black with grey veins and contains much oil.

[References.—*Linschoten*, I., pp. 120, 121, 150; II., pp. 105, *et seq.*; *Bontius and Piso*, lib. iv., p. 43; *Ainslie*, I., p. 378; *Khory*, p. 280.]

NOTE.—In the preceding pages the words *Malaio* and *Malaios* of the original have been rendered Malaya and Malays. This is without prejudice to the specific signification which may be attributed to these terms, and also to the name Malacca. In particular cases, they stood for Borneo, Sumatra, &c.

(*To be continued in* PART II.)

XXXVI.

ON THE USE OF TWO INFLEXIONAL FORMS OF THE VERB IN IRISH.

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[Read MARCH 15, 1890.]

On the Enclitic *Ending* -ann.

MODERN investigation has established so many new points in reference to Irish grammar that it may be said, without any liability to an accusation of prejudice, that no authoritative Irish grammar is in existence. Whether it be now possible to establish the principles of Irish grammar on a right basis, and to free the written language from the abuses that have crept into it by neglect and misunderstanding, is a problem that time alone can solve. Meanwhile, it undoubtedly rests with those who take an interest in the maintenance of this time-honoured language, to do what they can in the way of reform, so as to train the younger generation to avoid what can be shown to be wrong.

The source of much of the evil is in the existing Irish grammars, where, indeed, the entire theory of the Irish verb is so wrongly set forth, that each new generation of students only adds to the confusion. In my edition of Keating's Trí Bior-ġaoiṫe an Ḃáis, just published by the Academy for the first time, I have endeavoured to set forth some of the principles observed in the better times; and the present Paper is intended to call attention to some of the most necessary of the modifications that will have to be effected in the teaching of the modern language.

[I.]

The usual teaching on the subject of the so-called *consuetudinal present* tense in Irish is quite wrong; but, fortunately, the means of illustrating and correcting the errors are in our hands. But before any step is taken, the student must make it his duty to attain to a clear understanding of the function of the ending -ann, viz. *enclitic*, because nearly all the modern abuses in the verbal system are connected with the ignoring of the principle involved in that term.

By *enclitic*, then, is meant the form that the verb assumes when it is used in immediate connexion with the negatives ní, naċ, the interrogative an, the particle go, or the relative governed by a preposition [also including dá and later má].

This presents no difficulty to an Irish-speaking native; his own commonly used verbal system will show it to him at once in the use of the *irregular* verbs. He will say:—

> atá (sé), but ní ḟuil (sé), go bfuil, an bfuil, &c.;
> bí (sé), but ní raib, go raib.

Very well: the forms fuil and raib are *enclitic* forms.

Now, the first point to which I call attention is the fact that the so-called *consuetudinal* present is neither more nor less than an *enclitic* form; it does not serve to express one iota of habit or custom, or anything else whatever than this *enclitic position*.

In other words we *must* say: ní ṁolann (sé), naċ molann, go molann, an molann, &c.; and we *must not* use it save in this *enclitic* position, and that, too, only in the *singular 2nd and 3rd pers.*

That is the usage in Irish proper; and any other usage is mere *patois*. Thus, it is sometimes said that coṁnuiġeann sé is the equivalent of an Anglo-Irishism, 'he *does be* living.' They are both equally wrong: the fact of the common usage of them does not make them correct. And in fact the use of

> coṁnuiġeann mé, I *does be* living,
> coṁnuiġeann siad, they *does be* living,

is quite on a par as to grammatical concord.

But, indeed, apart from the grammatical concord, the meaning attached is indefensible: **there is no such thing as a simple consuetudinal present tense in Irish at all.**

[II.]

Nothing can be more instructive on this matter than the investigation of the different editions of works published in Irish during the present century. The use in the Keating [*ob.* 1644] is so uniform that it were mere waste of time to set forth all the examples. The following instances occur in the First Book:—

3, 26; 5, w; 12,14; 14, 2 go ndliġeann.
6, 24 naċ leiġireann.
7, 3 ní ġaḃann.
12, 4 go múċann.
12, 21 go gcaoṁnann.
12, 28 naċ féadann, 22, 15.
17, 3 go ndealuiġeann.
19, 1 go dturnann.
23, 1 ní ḟéaċann.
25, v go ndoirteann.
26, 28 go ḃféadann.
32, x gion go saorann.
34, 6 lé marḃann.
34, 10 go ḃfágḃann.
34, 19 tré n-a n-imreann.
35, 8 go ḃfaġḃann, 35, 23.
35, 12 go ndealuiġeann.
35, 25 mar a laḃrann.
37, x i ḃfaġḃann.
38, 22 ní ḟaoṁann.
38, 27 naċ claoċluiġeann.
39, 6 mar a n-imḋeargann.
39, 8 go gcuireann.
41,6,17 go mbeanann.
42, 12 ní ḟágḃann.
42, 29 go ḃfuilngeann.
45, 30 naċ déanann.
46, 27 go ndliġeann, 51, y.
46, z naċ éisteann.
50, 4 naċ gaḃann.
51, 5 naċ féadann.
53, 17 naċ séideann.
53, x naċ sroṁann.
53, y naċ faiceann.
54, 1 naċ déanann.
54, 2 naċ moċuiġeann.
54, 7 naċ gaḃann.
54, 8 d'a ndéanann.
56, 2 go n-oibriġeann.
56, 6 go ngníoṁuiġeann.
56, 21 go sáruiġeann.
56, 30 go gcuireann.
56, w go mbeireann.
57, 3 cion a ḃfaġḃann.
60, z go ḃfaiceann.
61, y naċ éisteann.
61, z naċ gaḃann.
65, 10 go ḃfágḃann.
66, 23 go dtógḃann.

The structure throughout the whole work is quite uniform and simple: we find everywhere for the 3*rd singular*:—

(*a*) **Independent** form, molaiḋ (sé).
(*b*) **Enclitic** ,, [ní, naċ, go, an], molann (sé).
(*c*) **Relative** ,, [no particle] ṁolas.

Next, take the *Lucerna Fidelium* of O'Molloy [1676], where every page exemplifies the principles here referred to. O'Molloy uses the -ann form quite correctly as an enclitic.[1] Thus, for question and answer respectively, he uses *invariably* the forms -ann and -aiḋ in *singular* as prescribed by the rule: *cf.* 127, y an ḃfoġnann? foġnaiḋ; 267, 7 an leanann? leanaiḋ; but in *pl.*, only -aid: 179, y an ḃfuiġid? 268, 1 an gcreidid? He uses only bí: *cf.* an mbí? bíḋ, ní ḃí, 128, v, x; 129, 6, 8; 133, 12, z; 134, 2, &c.; and he never writes biḋeann; *cf.* 66, 10 do ḃríġ go mbi gach aonduine 'n-a naṁaid ag Dia . . . 7 fós go marḃann an tanam. But he never uses the enclitic -ann save in its proper place; thus he writes: 206 nach bainmid do Ḋia; 208 [an] tan ġuiḋemid; 208 gach n-uair ġairmid orra; 228 ní mó ċuigmid; nach mó ḃeirmid; *3rd pl.*, 209 ní mó ṁeasuid na Catoilice; 213 go dtuguid na naoiṁ; 214 an ṁéid go dtaisbeanaid, &c.

Now, take Donlevy's *Catechism* in Irish and English, published in 1742, and the same use is observed. Here we find[2]:—

4, 13 go ḃroḃlumann neach; 12, 5 ré 'ḃfoillriġeann (sé); 20, 10 an ḃfaiceann Dia [as if from *simple* root faic]; 20, 14 creud fá n-abrann tu [as if from *simple* root abr]; 20, 17 go dtugann; 20, 19 nach dtuiteann; 52, 11 an ndeunann tu [as if from simple root deun]; 52, 17 nach gcoiṁeudann; 56, 5 go mbronnann tu; 56, 7 an gcoisgeann an aiṫne; 56, 8 ní ċoisgeann, &c.

I have carefully gone through the whole book, and cannot doubt that the writer was thoroughly conscious of the law he was obeying. His formulas are—

Independent,	It hinders,	toirmeasgaiḋ[3] sé.
Enclitic,	Does it hinder,	an dtoirmeasgann sé.
	It does not hinder,	ní ċoirmeasgann sé.
Relative,	The law which hinders,	an aiṫne [do] ċoirmeasgas.

[1] But he extends its use also to the *2nd pl.*: cf. 202 go n-aḋrann sib; 206 go measann sib; just as he also uses ṁeasas sib, 212; ċuigeas sib, 235, &c.

[2] So always after gach a, 8, x gacha múineann an eaglais; 12, 13 gach a múineann tu, &c.

[3] Oftener written toirmeasge, as the ḋ was not sounded.

But in the *plural* he does not use -ann ; thus :—

42, 22	go ndéanamaoid-ne.	46, 8	an eiséireochaid an drung?[1]
46, 5	go n-eireochaid na daoine.	46,w	cá rachaid an drung?

Now, take the modernized edition of this *Catechism* by O'Reilly [1822]. Cf. *e. gr.* :—

Donlevy, p. 142 :—	O'Reilly, p. 116 :—
orduighe sí [*i.e.* orduighiḋ sí].	orduigheann sí.

Here we have the wholly unwarrantable *modern* use of the ending -ann.

Or take the edition of O'Gallaher's *Sermons* by Canon Bourke, 1878, where the same alteration is observable, though, of course, it had begun in the old edition. On p. 44 we have a paragraph, which may be given as a specimen :—

44, 21 Anns an t-saoghal-so . . . éirigh*eann* gach nidh . . .; ann âit sin, teagmh*ann*. . . . Onóruigh*eann* . . . agus tarcuisnigh*eann*. . . . Bidh*eann*. . . .

In every case here, the old edition [1807] preserves the proper form, p. 29[2]—the *independent* form, badly spelt no doubt, but with a perfectly just appreciation of the fundamental difference in the function of the two endings, -eann and -iḋ.

In the so-called Munster-version of the N. T. [1858], the wrong use of the ending -ann is very common. The 1st chapter of St. John contains the following instances of the improper use :—

Verse 5	agus soillsighion an solus.	Verse 27	an té ċigion.
9	an solus, do ḟoillsighion.	29	Uan Dé, ṫógan peaca an d.
12	an dreám, do ċreidion.	30	tigion duine.
15	an té ċigion.	33	an té ḃaisdean.
23	an té liúġan.		

[1] Nouns of multitude are treated as *either* singular or plural, much as in English.

[2] Here the text is :—eirigh*e* gach ni . . . n-ait a dteagmhuinn [after *prep. cum relat.*]. Onoraidh . . . tarcuisnidh . . . Bi . . .

[III.]

The edition of the Gospel of St. John published by Connellan, from the London edition of 1828, which was taken from the [London] edition of 1608, is very instructive. I do not attach the slightest blame to Connellan, nor indeed to any one of the men who have 'stood in the breach' on behalf of this venerable language: errors are not necessarily crimes; and it is always very difficult to guide the developments of a language brought into contact with a powerful rival.

The position is this: in the old speech the usage in reference to certain forms was definite and intelligible, but the tradition was somehow interrupted; and when the dry bones of the valley were stirred, and roused into life again, it is not wonderful that some of the joints were ill-set, and do not work harmoniously.

Connellan was quite unconscious of the confusion he was producing, and would, no doubt, have rejoiced to see himself put into the possession of some definite rule that he could follow steadily.

A cursory examination suffices to show that Connellan's variations from the older text were not owing to any clearly conceived theory or any settled practice, *e. gr.*:—

iii. 26 feuċ, baisdiġ sé, 7 tigean na huile [ḋaoine] ċuige.
"lo, he baptizeth, and all men come to him."

Here there was just as much reason for giving to the first verb a *consuetudinal* ending, as to the second; the older edition has of course tigid.

x, 14 aiṫniġim mo [ċaoiriġ] féin, 7 aiṫniġeann mo [ċaoiriġ] féin mé.
"I know my own sheep, and my own sheep know me."

The old text has aiṫniġid.

xv. 6 ann-soin cruinniġeann daoine, 7 cuirid 'sa teiniḋ iad.
"Then people gather and put them into the fire."

The matter is here raised to demonstration: there was no force whatever in the ending -ann, as used by Connellan. And he does not put it even in cases where the theory seemed to call for it; *e. gr.*, iii. 34, an té do ċuir Dia uaḋ, labraiḋ sé briaṫra Dé; or again, iii. 36, coṁnuiġiḋ fearg Dé air. If

the ending -ann had *really* conveyed the meaning which the later grammarians have claimed to discover in it, the instances would have been numerous and convincing. It is plain that it was used by Connellan as an optional form, its frequent occurrence being a matter of simple intuition, and the rules that determined its usage having been forgotten.

Its normal use, in the enclitic position in *2nd sg.* and *3rd sg.*, is very common:—

i. 25 créad fá ndéanann tu? ii. 18.
i. 38 ga a gcoṁnuiġean tu?
i. 58 an gcreidean tu?
iii. 33 ní ġlacan aon-nduine.
iv. 37 ní síolċuireann neaċ.
iv. 37 go mbaineann neaċ.
v. 23 an té naċ n-onóraiġeann.
v. 23 ní onóraiġeann sé.
vi. 61 an dtugann so?
vi. 64 naċ gcreideann.
vii. 19 ní ċoiṁlíonann aoinneaċ.
vii. 51 an ndaorann ar ndliġeaḋ?
viii. 35 ní ċoiṁnuiġean an seirḃis-eaċ.
viii. 36 má ḟaorann an mac.
viii. 37 ní ḟaġann mo ḃriaṫar.
ix. 4 naċ ḃfeudan aonduine.
ix. 16 ní ċongḃan sé.
ix. 31 naċ n'éisdean Dia.
ix. 34 a dteaguisgeann tu?
ix. 35 an gcreidean tusa?
ix. 39 na daoine naċ ḃfeiceann.[1]
x. 18 ní ḃeireann eunduine.
[ḃeir is used here as a *simple* root.]
x. 21 an ḃfeudann an diaḃal?
x. 29 ní ḟeudan éinneaċ.
x. 33 go ndeunann tu (*cf.* xvi. 2), [with deun as *simple* root].
xi. 9, 10 má ṡiúḃlann duine.
xi. 9, 10 ní ḟaġan sé.
xi. 26 an gcreidean tu?
xi. 40 má ċreideann tu.
xii. 34 go ḃfanan Críosd.
xii. 35 gá háit a ngaḃann sé?
xii. 48 giḋ bé naċ ngaḃan.
xiii. 35 má ḃíon gráḋ.
xiii. 36 ní ḟeudan tusa.
xiv. 10 naċ gcreideann tu?
xiv. 17 naċ ḃfeudan an saoġal.
xiv. 17 naċ ḃfeiceann sé.
xiv. 24 giḋ bé naċ ngráḋuiġeann misi (non amat me).
xv. 1 géug, naċ dtugan.
xv. 4 naċ ḃfeudann an ġeug.
xv. 7 má ḟanann siḃ.[2]
xv. 7 má ḟanann mo ḃriaṫra.[3]
xv. 18 má ḟuaṫuiġeann an saoġal.
xvi. 5 ní ḟiarruiġeann éunduine.
xvi. 5 cá háit a dtéiġeann tu?
[Ed. of 1602 has dteid tu.]
xvi. 9 naċ gcreideann siad,
[wrong: gcreidid siad].
xvi. 21 ní ċuiṁniġeann sí.
xvi. 29 ní laḃrann tu.
xvi. 30 naċ riġeann tu a leas.
xviii. 20 mar a gcruinniġeann na iúdaiḋe [wrong; rest have -iġid, of course].
xviii. 21 creud fa ḃfiarruiġeann tu?
xviii. 23 creud fa mbuaileann tu?
xix. 10 naċ dtugan tu?
xix. 12 má léiġean tu.
xx. 15 creud fá a nguileann tu?

[1] This is correct, and according to rule; for in *who*-clauses the verb is in the *singular*, and therefore properly has the *enclitic* ending, the root faic- being used as a *simple* root.

[2] Not wrong, for the usage varies; but the edition of 1602 has ma antaoi.

[3] Plainly wrong, as the subj. is *plural*; and the other editions have [ḟ]anaid.

The rules are :—(*a*) With a *plural* subject, the ending -ann cannot be used (save in the very special case of the *who*-clause *negative*). In the old version we have :—

3,12 nać gcreidtí; 4, 9 ní ġnáċuiġid na hiudaiġe; 5, 23 onóraid siad [as *always*], where Connellan gives onóraiġeann siad, wrongly, through the misunderstanding of the next clause in the verse, where there are two instances of its correct use; 5, 36 beirid siad [C. beirean siad]; 5, 38; 6, 36; 8, 45 ní ċreidtí; 5, 44[2] an tan ġabtaoi, nać n-iarrtaoi; 5, 45 'n-a gcuirtaoi-se; 6, 53 muna n-ittí; 7, 19 s'a n-iarrtaoi; 7, 26 ní abraid; 8, 24 muna gcreidtí; 8, 31 má ċoṁnuiġtí-se; 11, 48 má ḟuilngimíd; 15, 7 má ḟanaid [C. has ḟanann]; 16, 9 nać gcreidid siad [C. has gcreideann siad].

(*b*) In the *independent* position, it cannot be used at all. Hence v. 17, Connellan's oibriġean m'aċair is impossible.

[IV.]

But perhaps it may be objected that this form *may* really nevertheless have the *consuetudinal* force alleged. The examples are abundant enough to disprove it; thus, John viii. 35, we have ċoṁnuiġeann an seirḃíseaċ, and má ḟaorann an mac, but fanaiḋ an Mac go sioṙraiḋe. Again, ix. 31 nać n-éisdeann, but éisdiḋ sé. Again, xii. 24 fanaiḋ sé 'n-a aonar; but xii. 34 go ḃfanann Críosd go síorraiḋe. It is clear from the two examples,

8, 35 fanaiḋ an Mac go síorraiḋe,
12, 34 go ḃfanann Críosd go síorraiḋe,

that the only reason why the -ann ending was used in the one case, and not in the other, was its obedience to a formal law: it had nothing to do with any intensification of meaning. Or again, take xiv. 17, in speaking of the Spirit of Truth, nać ḃféadann an saoġal do ġaḃáil, ar an áḋḃar nać ḃfaiceann sé é: nać aiṫniġeann sé é; aċt aiṫeantaoi-se é; óir fanaiḋ sé agaiḃ, "whom the world *cannot* receive, because it *seeth* him not, and *knoweth* him not; but ye *know* him, for he *abideth* with you." Here, so far as the *meaning* of the terms is concerned, there could be no possible reason for the variation in the last; yet only *three* of the words have the -eann ending, and, as always,

by the definite rule. Or again, xvi. 29, 'now speakest thou clearly, and *speakest* no parable'; here there could absolutely be no sense of habitualness ('thou art not speaking at the present moment'), but it is ní labrann tu nevertheless, and correctly, by the rule; the *consuetudinal* force would actually make it mean 'thou *art not in the habit* of speaking parables!'

And to come nearer to our time, what is the construction found in the version of the Pentateuch by the Archbishop of Tuam, 1859? He gives Gen. xlii. 38 má beanann tubaisde dó, 'if any mischief befall him'; quite correctly, of course, but it has no *consuetudinal* force. Again, Gen. xxxii. 29 cread an fáth a fiafruigheann tu m'ainm, 'why dost thou ask my name,' with equally little reason of *consuetudinal* force. Again, lxii. 13 tá an mac is óige a brocair ar n-athar, 7 ní mhaireann an mac eile, where the tá would seem to need the consuetudinal more than the maireann, if any such meaning underlay the ending. Again, lxiii. 4 má chuireann tusa linn é, 'if thou send him with us': where is there even *room* for the meaning alleged?

And, finally, let any Irish-speaking native ask himself whether he *ever* omits to use this enclitic ending -ann after ní, nach, go, an, &c.; does he not *always* say:—

ní chreideann sé,	he does not believe.
an gcreideann sé,	does he believe?
go gcreideann sé,	(I think) that he believes.

I have no doubt that this is really even now the universal practice among those who speak Irish from their childhood; and were there even no further evidence than this modern extant use, it would be of itself sufficient to show that the ending -ann is simply a necessity of *position*, and has precisely the same relation to the normal ending -idh of 3rd sg. pres., that fuil has to atá.

In fact, comhnuigheann mé, for 'I dwell' is exactly on a par with sentences like the following:—

tabhair mé an leabhar,	for *I give* the book.
fuil mé a'm fear,	„ *I am* a man.

[V.]

It is in fact evident that this unwarrantable practice is quite modern, and belongs to the present century—no doubt, mainly owing to the influence of the extended use of English, and the consequent admixture and misunderstanding of the forms.

The *indefinite* [aoristic] English present is rendered by the Irish simple present:—

molaiḋ ſé, he praises.

The *immediate* present is made in both languages by periphrasis:—

he is [*now*] praising, aṫá ſé ag molaḋ.

But the Irish has further a *verb* of HABIT:—

he is [habitually] praising, bí ſé ag molaḋ.

It is to the last of these three forms that the Anglo-Irish expression he *does be*, &c., corresponds:—

bí ſé ag ḋul ann aṗ maiḋin,
he *does be* going there in the morning.

Now, the practice of using the enclitic -ann with negatives, as ní ṁolann ſé, brought about ní ḃi[ḋ]eann ſé, for 'he *does not be*,' &c. With the introduction of this biḋeann (which never occurs in the Keating, though it crept early into the language, through the influence of analogy[1]) every preparation was made for going astray, for the meaning of *habit*, which lay in the VERB bi, was ultimately transferred to the ENDING -ann; and through the constant use of 'he *does be*' in Anglo-Irish, the dissemination of this biḋeann, combined with the familiar usage of the ending -ann, wrecked the proper construction of the latter, and opened the way for the verbal corruption that ensued.

[1] It is noticeable that in Halliday's *Grammar* [1808], p. 72, the *consuetudinal or habitual* mood of the auxiliary beiṫ by implication limits the use of this ending to the *2nd and 3rd singular;* though at p. 75, in the verb céṙ, he uses it throughout the plural.

On the Relative *Ending* -AS, [-FAS].

The doctrine of the Relative clause, which in the early Irish prose is fairly consistent and intelligible, has been so obscured by groundless theorising and illegitimate deductions, that a succinct statement of the excellent practice of the early writers can hardly fail to be of service.

In modern Irish there is no word or particle of any kind whatever to express the 'relative' connexion of two clauses, unless in cases where the construction stands in need of a preposition to govern such (relative-) word: the relative-connexion is expressed simply by direct sequence, and that whatever be the tense.

The precise relation, however, of antecedent to relative is not determined in this mere juxtaposition: *cf.* Latin *homo* [*qui*/*quem*] *amavit;* and we have therefore to consider what difficulties might arise, and how these are obviated in Irish. In such sentences as 'the man whom he struck,' it is evident that even if the relative 'whom' were omitted, the *relation* of the clauses is clearly determined by the pronoun *he.* Again, in the sentence 'the man whom John struck,' the *relation* of the clauses, even in the absence of the relative, is manifested by the *position* of the words 'John' and 'struck,' and in fact we frequently omit this *acc.* relative, when the subject of the relative clause is named, *e. gr.* 'the man he struck,' 'this is the man John struck,' where the sense is quite intelligible. Now, the point to be distinctly grasped, in Irish syntax of relatives, is that there is NO WORD CORRESPONDING TO THE ENGLISH 'WHO' OR 'WHOM,' unless where the 'whom' is governed by a *preposition.* But with the appearance of a *preposition,* though the mere sequence is often quite sufficient,—for even in English, we say, 'the subject he talked *of,*' 'the man he met *with,*' and in modern Irish, where the composite *prepositional pronoun* is at hand, these sentences, an níḋ, do ṫráċt sé air, an fear do casaḋ air [or leis], are perhaps even commoner than in English,—yet neither in English nor in Irish is such construction felt to be correct; and we *write,* 'the subject *on*

which he is speaking,' just as in Irish, an níḋ ar a dtráċtann sé. Here comes in the new element, a *real pronominal element*, in the a that follows the *prep.* ar. This a is the vowel-remnant of a pronominal *an-*, the final *n* of which manifests itself in the *eclipse* of initial consonants, and in the n- prefixed to initial vowels. But, when the tense is a *past* tense, a difficulty arises: what is to become of the *prefix* of the *past*, viz. do (as in do ḃuail sé, 'he struck')? There were two prefixes in use in the older Irish for this purpose, do and ro; the latter has wholly gone out of modern use, *save in the dependent clause*, where we have níor ḃuail sé [for *ni ro* buail], gur ḃuail se, &c.; this remnant *r'* assimilates the final *n* of the (*prep.*) relative to itself, giving as a resultant of the *relative* and the *past-prefix*, a form a'r, [for *a*(*n*) + *r*(*o*)]. Here, as the *ro-* prefix causes *aspiration* of initial consonant following, the eclipsing that would otherwise attend the relative is necessarily stopped; *cf.*:—

Pres., 'the thing of which he is treating,' an níḋ ar a dtráċtann sé.
Past, 'the thing of which he treated,' an níḋ ar a'r ṫráċt sé.

After a *preposition ending in a long vowel*, the vowel of the relative element is absorbed, leaving as its only remnant the eclipse of the following initial, and the use of the prefix r in past tenses:—*Keating*, 1,7 ó 'r-ḟásadar, 'from whom they sprang,' [for *o an ro-f.*]; 8, 27 lé 'ḃféadfaḋ [for *lé anf.*]. Of course, in the *passive* voice where the prefix do does not cause aspiration, neither does its substitute ro; thus 3, 6 lé 'r-turnaḋ.

The teaching of modern Irish grammars on this point is totally wrong: it has produced a relatival a, which [in *nom.* or *acc.*] has no existence, and O'Donovan adds to the confusion (*Gram.*, p. 131) by stating that the perfect particle do *stands for* the relative.

Let us consider simple cases. 'The man who strikes' is an fear ḃuaileas; 'the man whom he strikes' is an fear ḃuail-eas sé; it is evident here that the *case* in which the relative is to be taken is not determined *by the form of the relative verb.* But if the sentence be, 'the man who strikes me,' an fear ḃuaileas mé, or 'the man whom I strike,' an fear ḃuailim, the very form of the verb makes the meaning clear: the aspiration

of the verb shows the 'relatival' relation, but the subject of the relative verb is manifested by the verbal ending.

Therefore, ambiguity can rarely arise, if the proper construction is observed; and the instance of ambiguity given by O'Donovan (*Gr.*, p. 378) is owing entirely to grammatical error. He says: "ᴀn ꝼeᴀꞃ ᴀ ḃuᴀıleᴀꞅ may mean either 'the man *who strikes*,' or 'the man *whom I struck*.'" But this is to obliterate the distinctions, and ignore the functions, of the verbal forms, viz.:—

ᴀn ꝼeᴀꞃ ḃuᴀıleᴀꞅ, . .	'the man who strikes.'
ᴀn ꝼeᴀꞃ ᴅo ḃuᴀıleᴀꞅ, .	'the man whom I struck.'

Here the unhappy insertion of ᴀ, and the still more unhappy option of ᴀ for the *perf.* prefix ᴅo, ruin the construction.

Again, when O'Donovan employs ᴀn ꝼeᴀꞃ ᴀ ḃuᴀıl mé as 'the man *who struck me*,' or 'the man *whom I struck*,' he introduces a needless ambiguity, for the latter should be ᴀn ꝼeᴀꞃ ᴅo ḃuᴀıleᴀꞅ, with the indispensable perfect-prefix ᴅo.

In fact this ᴀ is really only ᴅo misspelt:—

'The man who struck him,' . .	ᴀn ꝼeᴀꞃ ᴅo ḃuᴀıl é.
'The man (whom) he struck,' .	ᴀn ꝼeᴀꞃ ᴅo ḃuᴀıl ꞅé.

The ᴅo is simply the sign of the *past* tense, but in pronunciation the ᴅ is constantly thinned off into the aspirated ᴅ̇, and often disappears in sound altogether; hence this ᴅo constantly *appears* as ᴀ, for (ᴅ)o; but this proclitic is not a relative.

Three particles are constantly in modern books brought into operation quite wrongly to act as a visible relative pronoun, viz. ᴅo, ᴀ, and noċ. Of these ᴅo is not a relative at all; ᴀ is only a relative when governed by a preposition; and noċ is an indefinite pronoun in the dative case [Old Ir. nom. *nach;* gen. *neich;* dat. *neuch,* growing into later *do neoch,* and so (*do*) *noch, de eo-quod*]. 'The man who praises me' is ᴀn ꝼeᴀꞃ ṁolᴀꞅ mé, and *not* ᴀ ṁolᴀꞅ, or ᴅo ṁolᴀꞅ, or noċ ṁolᴀꞅ, or any other form whatever: the *relative present* is simply ṁolᴀꞅ.

Before treating of the special rules of this form, it will be well to premise one or two general observations. The device by which prominence is given to any notion in a sentence, viz. by placing it in an introductory clause after the assertive verb, involves the constant use of the relative form of the verb to express this subordination. Thus 'he praises his father *for this*' would be, when emphatically put, '*it is for this* that he praises his father,' is uime sin ṁolas a aċair. This I call the *subordinate* clause. Further, in the simple relative clause when the relative is not governed by a preposition, the [understood] relative must express either a *nominative* or an *accusative;* and here, as we shall see, a sharp distinction is made in the use of this form in -as. Take, *e. gr.*:—

[I.] The man who-praises him, an fear ṁolas é.	The men who-praise him, na fir ṁolas é.

These I call *who*-clauses.

[II.] (*a*) The man whom he praises, an fear ṁolas sé.	(*a*) The men whom he praises, na fir ṁolas sé.
(*b*) The man whom they praise, an fear ṁolaid siad.	(*b*) The men whom they praise, na fir ṁolaid siad.

These I call *whom*-clauses for convenience, even in cases where the relative refers to inanimate objects, where in English 'whom' could not be used.

The *subordinate* clause may be exemplified as above:—

[III.] It is for that reason that he praises. is uime sin ṁolas sé.

The *subordinate*-clause comes after nouns of time used as temporal conjunctions; thus '*when* they die' is rendered '[at] the time *that* they die; now, as the *subordinate*-clause follows the law of the *whom*-clause, the -as ending cannot here be used with *plural:* we have to write:—

Keating, 27, 24, an tan éagaid; while an tan éagas *can* only mean 'when *he* dies,' 19, 22.

The ground being thus cleared, we may proceed to the consideration of the practical treatment of the relative clause in

Irish, where the relative pronoun, if set down, would express a nominative or accusative. The rule is :—

In WHO-clauses, use the 3rd SG. as the Relative form for EITHER SG. OR PL. in all the tenses, save Pres. (and Fut.), where we must use the ending -as (and -fas); while in WHOM-clauses and in the SUBORDINATE-clause, the 3rd PL. must be used in all the tenses in connexion with a PLURAL NOMINATIVE.

The following examples, from the Keating, of the occurrence of this ending -as [eas], will probably suffice for practice :—

ḃeanas, 28, 22; ḃreóġas, 21, z; ḃriseas, 21, y; ḃloġas, 21, y; ḃíos, 3,15; 4,10; 6,12; 10,19; 12, 23; 13,19; 14, 3; 16, 22; 17,19; 18,10; 22, 1; &c.; ḃraiṫeas, 6, 31; ċaoṁnas, 21, 5; ċialluiġeas, 2, 2; ċeannsuiġeas, 24, 27; ċeileas, 7,11; ċoideólas (*fut.*) 24, 8; ċuireas, 18, 30; ċailleas, 27, 31; ḋliġeas, 5, 28; éagas, 19, 22; ḟágḃas [as if from simple root fágḃ-], 19,w; ḟuráileas, 19, 2; ḟéadas, 22,15; ġaḃas, 16,7; ġiallas, 18, x; léigeas, 7, 5; lingeas, 16,7; luaiḋeas, 17,10; ṁaireas, 12, 26; ṁiniġeas, 24, 27; raċas (*fut.*) 33, 22; ḟaoileas, 17,16; ṡileas, 28,7; smuaineas, 11, 12; ṡniġeas, 4,17; ṫeilgeas, 26, 2; ṫeagṁas, 10, 17; 16,w; 17,15; 26,1; 27, 5; 28, y; &c.; ṫeigeóṁas (*fut.*), 19,19; traoṫas, 16, 8; ṫréigeas, 11, 9; ṫuiteas, 3, 21; ṫursas, 26,7.

As for the structure almost any paragraph of the work will demonstrate the reality of the rule here laid down; but for convenience I quote one passage :—

Mo ṫruaġ, is eaḋ is nós dóiḃ, aṁail doġníd na héagcráiḃṫiġ, an tan atċluinid 'san seanmóir, coire troma d'a gcur i leiṫ an ṗobail, gurab eaḋ adeirid gur ris an tí-se nó ris an tí eile ḃeanaid siad, 7 ní ṫuigid iad féin do ḃeiṫ ciontaċ ionnta. Mar sin, an tan atċíd an t-éag ag breiṫ a gcoṁarsan, saoilid gurab orra sin aṁáin ḃíos a ċóir. Giḋeaḋ is truaġ naċ tuigid na i gurab ionann éiliuġaḋ an éaga ar gaċ aon ḃeireas an bás, 7 ar an druing ṁaireas d'a n-éis i gcoitċinne; ionnus naċ bí tearmann i gcionn aon-duine seaċ a ċéile aige.—"Trí Ḃior-Ġaoiṫe an Ḃáis," I. ii. 28 (p. 22, 20).

"Ah, me! it is their wont to behave as do the unbelievers, when they hear in a sermon of heavy sins being laid to the charge of the people: they say, that such sins refer to so-and-so or to some other person, and they do not realise that it is they themselves who are guilty therein. In like manner, when they see death seizing their neighbours, they think that it is over these only his right extends. And pity it is that these wretched folk do not comprehend that he hath the same claim on everyone, alike over those whom he now seizeth and over the general multitude that remaineth behind; so that there is no defence against him to any one person more than to his fellow."

Nothing can be more certain and uniform than the usage in reference to the relative form, as exhibited by the above examples; *cf.* also p. xviii., in the Appendix to the Keating, where I have stated briefly the usage that prevails throughout.

In *whom*-clauses O'Molloy observes the same distinctions: *cf.* the examples:—

p. 18,16 cred ċiallaiġeas an focal ud,
but 18, x cred ċiallaiġid na focail ud.

In the *subordinate* clause, a plural *nomin.* demands -id :—

68, w cionnas ṫiocfaid ; 89,12 cionnas ṗeacaiġid na heitriceaḋa.

In *who*-clauses, he uses the form -as rightly with *plural nom.*:—thus, 26, z na puinc ḃeanas ris an diaḋaċt, 'the points that treat of the divinity.'

Taking Dunlevy's *Catechism* [Paris, 1742] we find the same definite usage:—

1. The relat. form in -as [-eas] has very frequently do prefixed, p. 2, neiṫiḃ, do ḃeanas ré; 6, Dia, do ḋoirteas; 52 giḋ bé do ḃriseas, &c.; but also, 54 cred é, ċuireas; 60 aṁuil ḟoillsiġeas sé, &c.

2. It is used with *2nd sg.*, 26, 44 cred (é), ṫuigeas tu; 52 sliġe, do ġlacas tu; 58 cionnas do ċruṫuiġeas tu, &c.

3. It is not used in *whom-clauses* with *pl.* subj., 36 cred do ċialluiġid na focail-se; 16 gur trom do ṗeacaiġid an ċlann; 48 na pianta, iocfaid; nor in the *subordinate* clauses, 68 is o'n Dbl, ġeiḃid gac eólus; but constantly with plural subject, in *who*-clauses, 80 na haiṫeanta do ḃeanas ris.

4. It is not used with other persons: 80 an gráḋ, do ḋliġmíḋ a solus, tré a gcreidimíd.

5. It is not used with the double-flexion verbs, p. 46, druing, do ġeiḃ bás; 48 na daoine, do ġeiḃ bás; 4 an tan do ḃeir aire.

In the Gospel of St. John this *relative form* in -as, (-eas), -fas, -feas, occurs more than a hundred times—about twice as many cases of the *present* as of the *future*—as follows:—

Pres., aḋras, 4, 24; aiṫniġeas, 1, 48 (tu); 10,15; ḃaineas, 4, 36[2]; ḃaisdeas, 1, 33; ḃeireas, 5, 39; ḃeóḋuiġeas, 5, 21; 6, 33; ḃios, 3, 36; 5, 7; ċluineas, 6, 45; ċoiṁéadas, 14, 21; ċreideas, 1,12; 3,16,18,36; 5, 24; 6, 35, 40, 47; 7, 38; 11, 25, 26; 12, 44[2], 46; 14,12; ċuireas, 7,18; 8, 46; ḋaoras, 12, 48; [ḋéanas, 12, 26;] ḋiultuiġeas, 12, 48; ḋúisgeas, 5, 21; éisṫeas, 1, 23; éisdeas, 3, 29; 5, 24; 12,47; ḟanas, 15, 5; ḟoġlomas, 6, 45; ḟosglas, 10, 3; ḟreagras, 18, 22 (tu); ġabas, 13, 20[2]; ġlacas, 3, 33; ġráḋuiġeas, 10,17; 12,25; 14, 21, 23; iarras, 4, 9 (tu), 27 (tu); 7, 4,18; 8, 50; iṫeas, 6, 50, 54,

56, 57, 58; laḃras, 4, 26, 27 (tu); 7, 18; 8, 44; 9, 37; 16, 29 (tu); leanas, 7, 12; léigeas, 10, 4; ṁaireas, 11, 26; ṡeasas, 3, 29; ḟolċuireas, 4, 36; ṡiuḃlas, 12, 35; ḟoillsiġeas, 1, 9; ċaisbéanas, 2, 18 (tu); ṫógḃas, 1, 29; ṫuiteas, 12, 24.

Fut., béar(f)as, 6, 27; ḃias, 12, 35; 13, 29; 21, 18 (tu); ḃraiṫfeas, 21, 20; ḃus, 15, 7; ċluinfeas, 5, 25[2]; 7, 51; 16, 13; ċoiṁéadfas, 8, 51; ċreidfeas, 17, 20; ċuimneóċas, 10, 24 (tu); ċuirfeas, 14, 26; 15, 26; ḋaorfas, 12, 48; ḋéan(f)as, 21, 21; ḟoillseóċas, 16, 14, 15; ġlacfas, 16, 14, 15; iarrfas, 11, 22 (tu); íosas, 6, 51; laiḃeóras, 16, 13; raċfas, 10, 9; ṡéanfas, 13, 38 (tu); ṫiocfas, 4, 25; 7, 28, 31, 41; 13, 19; 14, 29; 15, 26; 16, 4, 8, 13.

As will be apparent, it is not used with a plural nominative in the *whom*-clause; but Connellan, in his revised text of St. John vii. 25 gives an é naċ é so an té iarras siad, quite wrongly, for the older iarraid siad; so on v. 25 Connellan has an tráṫ ċluinfeas na mairḃ guṫ ṁic Dé, quite wrongly, for the older ċluinfid.

Of course, when a *noun of multitude* is the subject, it may be accompanied by the *plural* or *singular* of its verb; but Connellan uses the option wrongly. Thus he has iv. 23, an tan aḋarfuiḋ an luċd. In this instance if an luċd is regarded as *plural*, the verb must be aḋarfaid [the old 1602 edition has ġuiḋfid]; if singular, it is the *relative* form in -fas that must be used, aḋarfas. But aḋarfuiḋ is impossible.

It will not be out of place to give examples in somewhat more detail, so as to aid the student in acquiring a definite knowledge of the excellent practice of the earlier writers.

WHO-clauses.

The man who praises, . . .	an fear ṁolas.
praised, . . .	an fear do ṁol.
will praise, . . .	an fear ṁolfas.
The men who praise, . . .	na fir ṁolas.
praised, . . .	do ṁol.
will praise, . . .	ṁolfas.

WHOM-clauses.

The man whom he praises, . .	an fear ṁolas sé.
he praised, . .	do ṁol sé.
he will praise, . .	ṁolfas sé.
The man (the men) whom they praise,	an fear (na fir) ṁolaid siad.
they praised,	do ṁoladar.
they will praise,	ṁolfaid (siad).

The following instances will suffice to exemplify the laws:—

PRESENT TENSE.

I. WHO-Clauses.

The man who-strikes, . .	an fear buaileas.
The men who-strike, . .	na fir buaileas.

In these *who*-clauses the relative form obtains throughout. [In general the language is adverse to constructions such as *I, who strike,* &c., but if used, they must follow the rule; *it is I who strike thee* would have to be rendered by is mise buaileas ṫu; but in these cases the language in general either uses some other construction, such as the emphatic affix buailim-se, or inserts a formal antecedent, is mise an fear buaileas ṫu.]

II. WHOM-Clauses.

Here the verb agrees with its subject, the *relative*-form in -as being only used with (2*nd* and) 3*rd singular*. Hence we have:—

The man [the men] whom I strike,		an fear [na fir] buailim.
	thou strikest,	buailir [buaileas tu].
	he strikes,	buaileas sé.
	we strike,	buailimíd.
	you strike,	buailtí.
	they strike,	buailid siad.

Of course, in the last example, siad cannot be used if the subject is expressed in the shape of a noun, *e. gr.*:—

The woman whom the men strike,	an bean buailid na fir.

These distinctions tend to obviate misunderstanding. Take, for instance:—

The women whom the men strike,	na mná buailid na fir.
The women who-strike the men,	na mná buaileas na fir.

There is certainly great advantage of definiteness in the structure by this rule; whereas the confusion which the modern misuse has introduced is serious.

III. SUBORDINATE-Clauses.

The rule is precisely the same as in *whom*-clauses. Thus :—

It is for that reason that I strike,		is ar an aḋbar sin buailim.
	thou strikest,	buailir [°leas tu].
	he strikes,	buaileas sé.
	we strike,	buailimíd.
	you strike,	buailtí.
	they strike,	buailid siad.

In all the above examples the construction is lucid and harmonious; neither a, nor do, nor noċ is necessary or allowable.

IV. PREPOSITIONAL-RELATIVE Clauses.

By these I mean the cases in which we have to use the oblique relative pronoun, a n- [causing *eclipse* in the *present*] under the government of some preposition; *e. gr.* :—

What is (the reason) for which I strike,		créad f'a mbuailim.
	thou strikest,	mbuaileann tu.
	he strikes,	mbuaileann sé.
	we strike,	mbuailimíd.
	you strike,	mbuailtí.
	they strike,	mbuailid siad.
What is the thing about which I treat,		créad an níḋ ar a dtráċtaim.
	thou treatest,	dtráċtann tu.
	he treats,	dtráċtann sé.
	we treat,	dtráċtamaoid.
	you treat,	dtráċttaoi.
	they treat,	dtráċtaid siad.

FUTURE TENSE.

Mutatis mutandis, the same regulations hold :—

I.

The man who will strike,	an fear buailfeas.
The men who will strike,	na fir buailfeas.

II.

The man [the men] whom I shall strike,		an fear [na fir] buailfead.
	thou wilt strike,	buailfir.
	he will strike,	buailfeas sé.
	we shall strike,	buailfimíd.
	you will strike,	buailfí.
	they will strike,	buailfid siad.

III.

As the cases under II.

IV.

In the *prepositional-relative* cases, the forms used are the normal forms throughout, because there is no *enclitic* form for the *future* of single-flexion verbs. Hence:—

Who is the person of whom I shall speak, cia hé an duine ar a dtráċtfad.
thou wilt speak, dtráċtfair.
he will speak, dtráċtfaiḋ sé.
we shall speak, dtráċtfamaoid.
you will speak, dtráċtfaoi.
they will speak, dtráċtfaid siad.

[As the *double-flexion* verbs have proper enclitic forms throughout, these will, of course, be used:—

créad f'a dtaḃarfad, [dtaḃarfair, dtaḃarfaiḋ sé, dtaḃarfamaoid, dtaḃarfaoi, dtaḃarfaid siad].]

Negative.

In *negative* sentences the *enclitic* form in -ann becomes very prominent:—

I. WHO-Clauses.

The man who does not praise, an fear naċ molann.
The men who do not praise, na fir naċ molann.

Cf. Keating: 129,18; ar na feiceadúiriḃ naċ díolann; 142,18 dronga naċ féadann; 200,12 na toicciġ naċ fóireann; [in all these cases the relative form -as would be used, of course, in the affirmative].

II. WHOM-Clauses.

The man whom I do not praise, an fear naċ molaim.
thou dost not praise, molann tu.
he does not praise, molann sé.
we do not praise, molamaoid.
you do not praise, moltaoi.
they do not praise, molaid siad.

There is one case where a difficulty arises, viz. when the subject or object of the verb is expressed as a noun, in the

singular; the context would have to define whether it was a *who*-clause or a *whom*-clause: *cf.*,

an bean nać molann an fear,	The woman { who does not praise the man. / whom the man does not praise.
na mná nać molann an fear,	The women { who do not praise the man. / whom the man does not praise.

But

na mná nać molaid na fir,	The woman whom the man do not praise.

Cf. also the cases where the subject or object is a *personal pronoun:*—

an bean nać molann sé,	The woman whom he does not praise.
na mná..............sé	The women whom he does not praise.
an bean.............. é	The woman who does not praise him.
na mná .... é	The women who do not praise him.
an bean nać molaid siad,	The woman whom they do not praise.
na mná .... siad,	The women whom they do not praise.

But

an bean............ iad,	[wholly incorrect], } read molann.
na mná .... iad.	[wrong], }

III. SUBORDINATE-Clauses.

Same as in II.:—

It is for that reason that I am not treating of it: is ar an aḋbar sin nać dtráċtaim air [dtráċtann tu, dtráċtann sé, dtráċtamaoid, dtráċttaoi, dtráċtaid siad].

IV. PREPOSITIONAL-RELATIVE Clauses.

Also the same. But the modern language is absolutely recalcitrant to this combination, and uses the negative relative adverb náċ, with a prepositional-pronoun as complement:—

What is the thing about which I do not treat,
créad an níḋ, náċ dtráċtaim air,

where the older language might have used:—

ar naċ dtráċtaim.

[Here of course the *eclipse* after naċ is indispensable, as the naċ is *nach n-*, with accusatival *n-* after prep. *ar.*]

Having thus fully exemplified the really difficult tense, the *present*, a brief notice will suffice for the *perfect;* it being understood that the perfect-prefix do must *never* be omitted in writing.

I. WHO-Clauses.

The man who struck,	an fear do ḃuail.
The men who struck,	na fir do ḃuail.

II. WHOM-Clauses.

The man [men] whom I struck,	an fear [na fir] do ḃuaileas.
thou hast struck,	do ḃuailis.
he has struck,	do ḃuail sé.
we have struck,	do ḃuaileamar.[1]
you have struck,	do ḃuaileaḃar.[1]
they have struck,	do ḃuaileadar.

III. SUBORDINATE-Clauses.

As II. :—

It is for that reason that I struck, is ar an aḋḃar sin do ḃuaileas.

IV. PREPOSITIONAL-RELATIVE Clauses.

Here, however, the new element comes in; for after the prepositional-relative, the prefix do is superseded by the other perfect-prefix ro, which blends with the oblique relative a(n)[2] into ar with *aspiration;* [ro aspirates, just as do]. Hence we have:—

What is the reason for which I struck,	créad f'ár ḃuaileas.
That is the thing about which he spoke,	is é sin n níḋ ar ár ṫráċt sé.
This is the place in which we lived,	is í an áit 'n-ár ċoṁnuiġeamar.
This is the father from whom they sprang,	is é an t-aṫair ó'r ḟásadar.

Negative.

Here, too, the prefix is ro, blending with naċ into nár [for naċ ro, naċ r', naċar], causing, of course, aspiration.

I. WHO-Clauses.

The man who did not praise,	an fear nár ṁol.
The men who did not praise,	na fir nár ṁol.

---

[1] In Munster the r is the thin-timbre r, both in *1st pl.* and *2nd pl.*; hence it is written do ḃuaileamair, do ḃuaileaḃair. This, however, is not to be commended. The *3rd pl.* has *always* the hard timbre r, do ḃuaileadar.

[2] The relative a is usually pronounced long, á'r.

II. WHOM-Clauses.

The man [men] whom I did not praise, &c.	an fear [na fir] nár ṁolas.

III. SUBORDINATE-Clauses.

Same as II. :—

It is for that reason that I did not praise, &c.	is ar an aḋbar sin nár ṁolas.

IV. PREPOSITIONAL-RELATIVE Clauses.

Indirectly, with the prepositional-pronom. complement :—

That is the thing about which he did not speak,	is é sin an níḋ nár ṫráċt sé air.
That is the place in which we did not dwell,	is í sin an áit nár ċoṁnuiġeamar innte.

In the *double-flexion* verbs [the so-called *irregulars*] the *relative* form is the form of the 3rd sg. *independent;* hence we get the following parallelism :—

	Independent.	Relative.	Enclitic.
Double-flexion,	doḃeir.	doḃeir.	ní ṫabair.
	doġní.	doġní.	ní ḋéin.
	atá.	atá.	ní ḟuil.
Single-flexion,	faoiliḋ.	ḟaoileas.	ní ḟaoileann.
	teaġṁaiḋ.	ṫeaġṁas.	ní ṫeaġṁann.
	tréiġiḋ.	ṫréiġeas.	ní ṫréiġeann.

In the *double-flexion* verbs, as such, the *enclitic* form in -ann does not occur :—

What is the reason for which I give,	créad f'a dtaḃraim.
thou givest,	dtaḃrair.
he gives,	dtaḃair sé.
we give,	dtaḃramaoid.
you give,	dtaḃarṫaoi.
they give,	dtaḃraid siad.

[The double-flexion verbs have not the relative form in -as or -fas, unless the root has come to be regarded as a simple root; thus déan, faic, and beir are often treated as if they were *simple* roots of that form originally.]

Of course, in all *whom*-clauses, the relative form will be in the *plural* with a plural subject; *e. gr.* Keating:—

36, 8 is ionann taisbéanaḋ doḃeirid uaṫa.
39, 6 is ionann foġail doġníd siad.

Now, it was in this confusion of use in *who*-clauses and *whom*-clauses that the error lay, which has helped to disintegrate the language.

Take, for instance, the two phrases:—

na fir, doḃeir an ċoṁairle, the men *who give* the counsel;
and an ċoṁairle, doḃeirid na fir, the counsel *which* the men *give*.

The verb must be as here written, in *sg.* and *pl.* respectively in these two cases: nothing can be more certain than the constant application of this rule.

But it is plain that to an unskilled mind, the use of doḃeir or doḃeirid must necessarily have seemed somewhat arbitrary, and to this may be attributed the notion that the use of either form was optional. It seems reasonable to infer that the extension of this (assumed) option to the verbs of *single-flexion* has had some share in bringing about the modern usage of the *analytic* molaiḋ siad for the older molaid.

XXXVII.

ON THE PLANE CIRCULAR SECTIONS OF THE SURFACES OF THE SECOND ORDER. By the Right Rev. Charles Graves, D.D., Bishop of Limerick.

[Read January 13, 1890.]

As a contribution to the theory of the surfaces of the second order, the Bishop of Limerick desires to state the general Proposition:—*That their umbilics and the circumferences of their plane circular sections are to the surfaces what their foci and focal circles are to the plane conics.*

The identity of the relation is proved by the existence of the same equation between the radii of the circles and the distances of their centres from the centre of figure.

In order to avoid multiplicity of cases, let us deal with the ellipsoid. We find that

$$\frac{d^2}{u^2} + \frac{r^2}{b^2} = 1,$$

where u is an umbilicar semidiameter on which the centres of one series of circular sections lie; d is the distance of the centre of one of those circles from the centre of the ellipsoid; r is its radius, and b the mean semiaxis of the ellipsoid

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1.$$

The following method of determining the normal at the point (α, β, γ) on that ellipsoid is closely related with the theorem just stated, and presents a simple method of conceiving the genesis of the circular sections. *Through the point* (α, o, β) *in the plane of the ellipse* (a, c) *draw two chords parallel to the semidiameters of that ellipse which are equal to* b, *the mean axis of the ellipsoid, the centre and radius of the circle which passes through their four extremities (for they will lie in a circle) will be the centre and radius of the sphere which intersects the ellipsoid in the two circular sections passing through the point* (α, β, γ); *and the radius drawn to that point will be the normal at it.* And further —*As a sphere inscribed in a right cone, which stands on an elliptic base, intersects that ellipse in a focal circle, so a sphere inscribed in a right cone, which envelopes an ellipsoid, intersects that surface in a pair of circular sections. These planes pass through the line common to the planes of contact of the right cone with the sphere and the ellipsoid,* forming with them a harmonic cahier.

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XXXVIII.

ON AN ANCIENT MS. LIFE OF ST. CAILLIN OF FENAGH, AND ON HIS SHRINE. By the REV. DENIS MURPHY, S.J.

[Read June 28, 1886.]

Two antique objects have lately come into my hands, by way of loan, through the kindness of their respective owners, the Archbishop of Cashel and the Bishop of Ardagh, which may be of some interest to the Members of the Academy. Both have reference to St. Caillin, the patron of the Clan O'Rourke, as Columkille was of the O'Donnells and Moling of the MacMorroughs, who were in ancient times chiefs of Breffney, the modern counties of Cavan and Leitrim, for O'Dugan tells us that "hereditary to the O'Rourke is that kingdom." Caillin's church and monastery are still standing, in part at least, at Fenagh, which is about three miles to the south-west of Ballynamore in Cavan.

Our Saint's genealogy is given in this book up to Rury, the grandfather of Fergus Mac Roy, who lived about the beginning of the Christian era. We are told, moreover, that "Finnlan, by whom he was fostered, commanded him to go to Rome to learn wisdom and knowledge there," a command which, no doubt, was readily obeyed, since one of the most common practices of our ancient saints was "peregrinari pro Christo."

The *Martyrology of Donegal* says of him, that "he was the son of Niatach, and bishop of Fiadnacha of Magh Rein. He was of the race of Cormac, son of Fergus, son of Ross, son of Rudraighe. Deidi, daughter of Tren, son of Dubhtach Mac Ua Lughair, was his mother. Maedhog of Ferns was a school-pupil of Caillin. He was an attenuated pious man; he was a virgin, he was chaste. He was a burning fire to burn the persecutors of God and of the Church. He was a sea without ebbing in signs and miracles." His feast-day is November 13th. None of our hagiographers have come down so far in the year as that: neither Colgan, the Bollandists, nor the Rev. J. O'Hanlon. They might be able to give us a life written critically. It is almost a

misnomer to call the contents of this MS. a life. It is rather a list of the lands, privileges, honours, and rights of sanctuary attaching to Fenagh, with an occasional allusion to St. Caillin.

The MS. which I have the pleasure of submitting to the Academy for inspection to-day would seem to be a copy of a more ancient Life, which the scribe who wrote the copy calls "the Old Book of Fenagh," and he says "there was only poetry in it." Unfortunately it is imperfect. The last folio is marked 48, and that it never had more we learn from a note at the end of folio 48 *b* by the scribe:

"Finit of all we have found of the Old Book of Caillin."

It has at present only 41. The only other ancient copy now in existence, so far as we know, that of the British Museum, is also imperfect; and though one supplements the other to a certain extent, yet the full text cannot be had even from both jointly. Which of the two is the more ancient, can be determined with certainty only by the inspection of both. The editor of the Life of St. Caillin thinks the British Museum copy only a transcript of this. Mr. Hennessy thinks it two centuries at least older.

The Life says "it was Tadhg that caused Maurice O'Mulchonry to put this book in a narrative form through the extent of his learning and through the excess of his devotion to Caillin." This was Tadhg O'Roddy, who came of a family that were hereditary comarbs of the church and monastery of Fenagh. He lived in the beginning of the sixteenth century, and was abbot of Fenagh. The precise date of the MS. is 1516. The Life says of him that "he was a man of wisdom and knowledge, of learning and jurisprudence, a reader of the Scotic, a man who composes Seghda and oglachas, and who observes the privileges and prohibitions of the place in which he is, to wit, that he should keep a house of general hospitality and not deny the face of a man, but be like an immovable rock in humanity for ever"—just such a man, I should think, as would make a scribe undertake and complete with a good will any task that would be set to him.

I may add that this Life has been published with a translation by the late Mr. D. H. Kelly, copiously annotated by Mr. Hennessy. Mr. Kelly seems to have spared no expense in its preparation for the press and in all that regards the printing. Would that others who can do so imitated his example, and by so doing rendered accessible to students of Irish, both at home and abroad, some of the vast treasures which are stored in this library and elsewhere, and of necessity out of

the reach of such as cannot come here to study. It is almost ungenerous to find fault even in the smallest way with such a valuable contribution to Irish literature. But I do not think it would have been amiss to have retained the initial capital letter for its own sake, as also for the peculiarity of Irish mediæval Latinity of which it is a specimen.

A few words on the second object exhibited: this is the shrine of Caillin. In the enumeration of the shrines made by Miss Stokes in her very valuable work on *Irish Inscriptions*, II. 159, no mention is made of this one. O'Curry has fallen into a strange mistake in reference to it. Having spoken at length of the well-known shrines, the Domnach Airgid and the Cathach, he makes mention of "several other shrines and reliquaries still remaining." "The chief of them," he says, "are that of St. Manchan, that of St. Maedog, which belonged to the O'Ruarcs of Breffney, but was lately in the possession of His Grace the Most Rev. Dr. Slattery, late Archbishop of Cashel; and the beautiful shrine of St. Caillin, now or lately in the hands of Dr. Petrie."

Much cannot be said of it perhaps as a work of art. It has but little of the characteristics of Irish ornamentation. The style of a good part of it is rather a debased Gothic. At the top is a figure of Christ crucified. The four panels into which the upper surface is divided contain each three figures, the whole representing no doubt the twelve Apostles, though they are without any distinctive emblems, each panel being nothing more than an exact facsimile of the others. A narrow band acts as a kind of frame for each of these panels, on which there is a very rich and varied style of ornamentation consisting partly of figures and partly of interlaced scroll-work. This, the lettering, and the bosses on the corner clamps, are in niello work of a very superior kind. Stones, mostly cornelian and spar, are placed at intervals immediately outside these bands; and in the centre a piece of spar much larger and higher than the rest. Round the edge there is an ornament, running from a stem ending in a six-leaved flower, a thing wholly foreign to ancient Irish art. On the back we have the usual plate with incised crosses, such as we see in the Cathach and other shrines in the Museum. Here, too, we have that strange irregularity both in the position and outline of each of the crosses as well in the pattern of the whole plate.

Round the edge of the upper and lower surface there is an Irish inscription in capital letters, partly Gothic, partly Irish; those on the upper edge being less than half the size of the lower. It begins at the left hand of the figure below, runs round the edge of that surface,

and is continued at the back. The letters face inwards. It reads thus:—

ORAID : DON : MFIR : DO : CVMDAIGH : AN : MINNSA : CAIL
LIN : ADHON : BRIAN : MAC : EOGAIN :
RVAIRC : AGVS : MARGREITE : INGIN :
HBRIAN : AGVS : DOBI : AOIS : AN

TIGEARNA : AN : TAN :
SOIN : SE : BLIANA
DEC : AR : XX : AR : M : AR
CCCCC : AIB^{S} : A MARIA

which may be translated thus:—

"Pray for the man who covered the shrine of Caillin, that is, Brian, son of Owen Ruarck, and for Margaret, daughter of O'Brian. And the year of our Lord then was MCCCCCXXXVI. A Hail Mary for their souls."

The plates, both upper and lower and the sides, are made in separate pieces, the whole being fastened very securely by means of solid clamps, which are themselves fixed on with long brass nails; the inside is lined with oak. From the way in which this has been shaped and hollowed out, it is evident that it was used to hold a book or relics, or perhaps both. As a fact, we find in the Life of Caillin that "he brought with him numerous remains and relics when coming from Rome, to increase the honour, respect, and right of sanctuary of his fair church of Fenagh of Magh Rein. The relics which Caillin brought with him from Rome were the relics of the eleven Apostles, and the relics of Martin, and of Lawrence, and of Stephen the Martyr. These are the relics which he subsequently ordered to be covered and enclosed in a shrine." Possibly it is in reference to these relics of the Apostles that the figures mentioned above have been placed on this shrine.

If it ever contained the Life of St. Caillin, it must have been the ancient one of which that now exhibited is a copy. This, though written some ten years before the shrine was made, could not by any possibility fit in it. Neither could the copy in the British Museum, for I have had it measured. It is 9½ inches in length by 6¼ in width.

This would allow it to fit in the box if there were no wood inside; but it is evident that the wood was part and parcel of the original shrine, which was much too small for either of the copies. I may remark here that most of the shrines now in existence were made for keeping books. However, there is one at least, the Fiacal Padruig, which was made for relics; and St. Manchan's shrine still contains a portion of his bones.

The date of the inscription will easily determine which of the O'Rourkes got the shrine made. In Archdall's *Peerage*, II. 24, we find that Margaret, eldest daughter of Turlogh Donn O'Brien, who was inaugurated King of Thomond in 1498, married Brian, Chief of the O'Rourkes. Frequent mention is made of this Owen in the *Annals of the Four Masters*. For instance, in 1536: Brian, son of Owen, who was son of Tiernan O'Rourke, was styled The O'Rourke; and in 1540: "the Castle of Leitrim," probably Dromahaire Castle still standing, "was erected by O'Rourke, Brian, the son of Owen, while a great war was waged against him on every side; and his own son and a party of the men of Breffney were at war with him. He finished the Castle in a short time, and destroyed a great portion of Moylurg on his opponents." And in 1545: "a great war was between O'Rourke (Brian Ballagh, the son of Owen) and his own brother by his mother's side, namely Teige, son of Cathal Oge O'Connor, lord of Sligo." His death is recorded in the year 1562: "O'Rourke (Brian Ballagh, son of Owen), the senior of Sil Feargna, and of the race of Aedh Finn, a man whose supporters, fosterers, adherents, and tributaries extended from the Caladh in the territory of Hymany to the fertile, salmon full Drowes, the boundary of the farfamed province of Ulster, and from Granard in Teffia, to the strand of Eothuile in Tireragh of the Moy, who had the best collection of poems, and who, of all his tribe, had bestowed the greatest number of presents for poetical eulogies, died in consequence of a fall; and his son Hugh Gallda was installed in his place."

The Four Masters make no mention of his wife's death. Archdall, in his *Monasticon*, says she founded the monastery of Crevelea on the western side of Lough Gill, opposite the O'Rourkes' castle of Dromahaire. This has been the burial-place of the O'Rourke family ever since.

I will only add that I am not without a hope of obtaining these two pieces of antiquity, if not as gifts for the library and museum of the Academy, at least as deposits, not, I trust, to be soon revoked.

P. S.—Since the above was written the MS. has been acquired by purchase for the Library of the Academy, and is now kept there.

XXXIX.

ON THE OCCURRENCE OF IDOCRASE IN THE COUNTY MONAGHAN. By Professor J. P. O'REILLY, Royal College of Science, Dublin.

[Read April 28, 1890.]

In October of 1888 I received, from Dr. Hall, of Monaghan, a sample of an iron and manganese deposit which, as he informed me, occurs in the townland of Calliagh, county Monaghan. The specimen forwarded presented, along with the well-marked iron ore, what appeared to be a thin rib or vein of quartz, penetrated by a straw- or honey-coloured mineral, having a lamellar, irregularly-radiated structure, in places distinctly plumose, which passed into the black ferruginous portion. This honey-coloured mineral I determined, from its density, 3·3407, and its hardness, about 5, to belong to the epidote group; and through the kindness of Professor Hartley, I was enabled to have it analysed by Mr. L. T. Spencer, then an associate student of the college. The results were communicated to me in June, 1889, and are as follows:—

Silica,	40·06
Alumina,	16·03
Lime,	37·46
Ferric oxide,	4·23
Manganous oxide,	1·16
Cupric oxide,	0·21
Soda,	1·00
Loss of moisture on heating to redness,	2·07
	102·22

The following formula was deduced from this constitution:—

$$7\,SiO^2\,2\,(Fe^2O^3,\ Al^2O^3),\ 7\,(CaO,\ MnO,\ CuO),$$

or, approximatively,

$$3\,(CaO,\ MnO,\ CuO)\,(Fe^2O^3,\ Al^2O^3)\,3\,SiO^2,$$

or, generally,

$$3\,M^{I}O,\ M^{III2}O^3,\ 3\,SiO^3.$$

In Zirkel's 11th edition of *Naumann's Mineralogy*, 1881, p. 528, the constituents of Vesuvian or Idocrase are given as ranging in the best analyses, as follows:—

Silica, ...	37 to 39
Alumina, ...	13 ,, 16
Ferric oxide, ...	4 ,, 9
Lime, ...	33 ,, 37
Alkalies, ...	0 ,, 1

The figures resulting from Mr. Spencer's analysis are practically within these limits. Zirkel adds that, in the cherry-blood red variety from Johnsberg, Silesia, 3·23 of MnO was determined by Von Lasaulx. Dana gives a series of analyses for the mineral, and mentions the variety, "*Xanthite*," a yellowish-brown Vesuvian from near Amity, N. Y., which contains 2·8 MnO, while a manganous variety from St. Marcel, Piedmont (where ores of manganese occur), has a sulphur-to honey-yellow colour, which fairly corresponds with that of the Monaghan specimen. This may, therefore, be regarded as a *Xanthite* variety of Idocrase. The presence of water, from 0 to 2·73 per cent., is noted in the series of analyses given by Dana; and its presence is usually attributed to partial decomposition of tho Idocrase mineral. This decomposition is quite apparent in places in the Monaghan specimen.

As Idocrase is not of common occurrence in Ireland, it may be interesting to note the localities in which it has been already observed. (For the earlier notices of the mineral I am indebted to Dr. Hyland, of the Geological Survey.)

1812. Stephens-Fitton, "Notes on the Mineralogy of part of the Vicinity of Dublin" (London, 1812), p. 45. Vesuvian (Idocrase, Hauy), Kilranelagh, Co. Wicklow, seemingly in a loose boulder, the author observing, that "appearances render it probable that they were not far from the natural place."

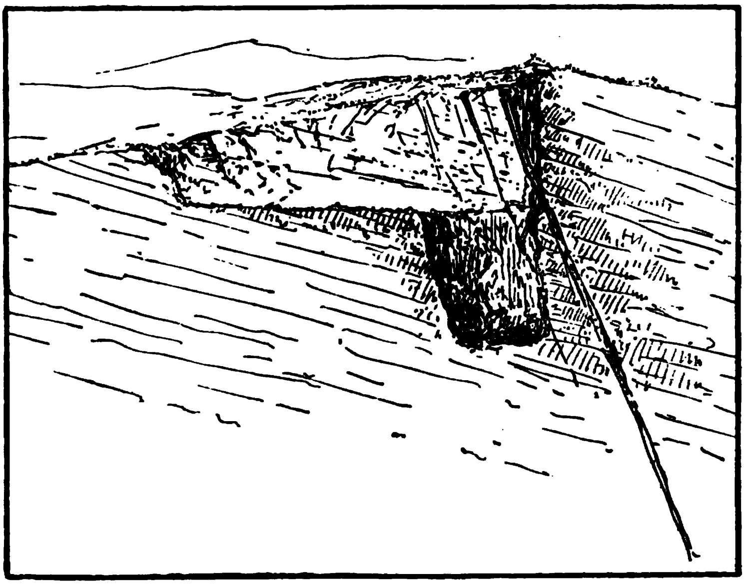
1826. Giesecke, "Account of a Mineralogical Excursion to the Centre of Donegal," p. 23. Barony of Boylagh and Bannogh, bacillary Idocrase of yellowish-brown and greenish-yellow colour from Lough Anure, in the Rosses, N.-W. Donegal. (This is a vein in granite.)

1858. Greg and Letsom, in their "Manual of Mineralogy," p. 101, mention as Irish localities, Derryloaghan, Barnes' Gap, near Kilmacrenan, near Lettermacherward; Bunbeg, Gweedore (in crytalline dolomite).

1861. Bristow, in his "Glossary of Mineralogy," mentions as Irish

localities, Derryloaghan, Co. Donegal (in prisms of a hair-brown colour), and also Bunbeg and Gweedore.

During the past Easter vacation I was able to revisit the locality, and determine more accurately the conditions under which the mineral occurs. The townland of Calliagh (pronounced *Káll-yĕh* by the inhabitants) lies nearly in the centre of a triangle of which Ballybay, Newbliss, and Monaghan are the summits, and may be reached by car from one or other of these points in about an hour's drive. The country presents a succession of hills, rather flatly conical than round, with patches of bog, bog-land, streams, or small lakes between them. It rises to an elevation of about 700 to 800 feet in the neighbourhood in question. The townland is shown on the 6-inch map of the Ordnance Survey Sheet, No. 13, of the Co. Monaghan; and the point where the mineral occurs is marked thereon as "Quarries." (Its latitude and longitude are, N. lat. 54° 11′ 5″, and W. long. 7° 1′ 45″.) Lying at a height of about 680 feet above the sea level, and forming part of a ridge which extends for several miles N.N.E. and S.S.W., it affords extensive views on nearly every side. About 1053 feet east of the quarry is the point known and marked as the "Giant's Grave," with an altitude of



706 feet. The Quarry forms the summit of the hill known locally as Logwood Hill (as well as I could catch the pronunciation from my

guide); but there is no name marked for it on the 6-inch Survey map. It appears as an excavation or cutting, having a length of about 25 yards (in the direction of the lode and hill), about 5 yards broad, and about 4 feet mean depth. The beds of Cambrian slate rock which are here transformed into an ore of iron and manganese, have a direction about N.N.E., and dip to the E.S.E. at about 15° to 20°. Further to the S.E., in the direction of Ballybay, the strata having much the same direction, dip at higher angles of 45° to 60°, and in places appear to be nearly vertical. On the S.E. side of the cutting, the highest side, occur two thin lodes, separated by an interval of about 2 feet, in the more S.E. of which the Idocrase occurs. This lode presents a thickness of about 3 inches, and has a direction of N. 28° E.; and a dip E.S.E. at about 60°, the direction being seemingly that of the ranges figured on Griffith's Map of Ireland, as occupying the greater part of the surface of the Co. Cavan. It might consequently be inferred that parallel fissures and lodes exist in these ranges, and that they may be metalliferous. The containing rock is the ore of iron and manganese already referred to, and which has been reported on by Mr. W. Adeney, Curator of the Collections of the Royal University of Ireland, as containing from 33·4 to 42·2 per cent. of ferric oxide, and from 5·9 to 7·55 per cent. of manganese peroxide. By his kindness I am enabled to give the complete analysis of a sample of the ore as it occurs in the immediate vicinity of the quartz lode in the Quarry. He describes the sample as follows:—"Taken from the S.-W. corner of the Quarry, soft, and easily broken up; purple-brown in colour, giving a red streak." This sample proved the richest in iron, and a complete analysis was therefore made of it.

SOLUBLE PORTION.

Ferric oxide,	42·20	per cent.
Alumina,	7·55	,,
Manganese peroxide,	6·24	,,
Cobaltous oxide, Nickelous oxide,	0·03	,,
Lime,	0·35	,,
Magnesia,	0·21	,,
Phosphoric acid,	0·03	,,
Water expelled at 120° C.,	3·21	,,
Loss on gentle ignition,	3·21	,,
Insoluble matter, ignited,	37·00	,,
	100·29	

INSOLUBLE MATTER.

Silica and titanic acid (trace), .	29·51	79·7	per cent.
Ferric oxide and alumina, . .	4·74	12·9	,,
Lime, ...	0·79	2·2	,,
Manganous oxide and magnesia,	0·87	2·3	,,
Soda and potash, ...	1·09	2·9	,,
	37·00	100·0	

It is interesting to compare this analysis of the insoluble matter with those of the orthoclase felsites, No. 2 and No. 9, given by Dana ("System of Mineralogy," 5th edition, p. 358).

	No. 2.	No. 9.
Silica, ...	81·24	79·55
Alumina, ...	9·78	11·31
Ferric oxide, ...	0·64	0·42
Magnesia, ...	0·21	0·10
Lime, ...	0·78	2·52
Soda, ...	3·34	3·68
Potash, ...	3·10	2·38
Water, ...	—	0·69
	99·09	100·65

As the insoluble portion of the sample analysed by Mr. Adeney was probably the part of the rock relatively unaltered, it may be presumed that the containing rock is really an altered felsite, and in this respect is comparable with certain of the Cambrian rocks which occur in the vicinity of Dublin. Judging it might be of interest to have the quartz vein assayed for gold, I forwarded, in November of 1888, samples of the iron ore and quartz to Mr. F. Claudet of London, and he reported having found traces of gold in the samples assayed.

The precise limits of the deposit have not been clearly determined; but from trials made in the neighbourhood of the Quarry, there can be no doubt but that it extends over a sufficiently large surface to allow of its being worked industrially if the ore could be utilized for the production of iron. That it is intimately related to the quartz lodes described, can hardly admit of a doubt; and that thermal action was the essential cause of the alteration of the rock is an inference which may be fairly drawn from the nature of the ore and its associations.

XL.

ON A SERIES OF COLOURED DRAWINGS OF SCRIBED STONES IN THE LOUGH CREW CAIRNS, BY THE LATE G. V. DU NOYER. WITH REMARKS BY W. FRAZER, F.R.C.S.I.

[Read April 28, 1890.]

An extensive series of coloured drawings, made by the late George V. Du Noyer, representing stones with remarkable sculpturings discovered in a group of Cairns situated on the summits of the Lough Crew Hills, County Meath, came into my possession some time since. They were intended to illustrate a work, giving full descriptions of the Cairns, by Eugene Conwell, M.R.I.A., who had the good fortune to discover them in the year 1863. He read three Papers to this Academy relating to their history on 23rd May and 14th November, 1864, and on the 26th February, 1865; and in July, 1867, Mr. Du Noyer was engaged to delineate them with a view to their future publication *in extenso*—a project that was never carried out owing to Mr. Conwell's removal to the South of Ireland, and his subsequent death. The value of Mr. Conwell's discovery was enhanced by these Cairns having escaped the notice of the Government surveyors, who should have recorded their presence on the Ordnance Maps.

Mr. Conwell in one of his Papers enumerated and gave a map representing 30 distinct Tumuli scattered along the crests of these Lough Crew Hills, all of which were carefully explored by him, and their stones enumerated in detail whenever he found they presented scribings.

Another of his Papers describes the Cairn he marked T on the map, the principal one of this group which he was induced to designate as the Tomb of Ollahm Fodhla, believing the entire group represented the missing burial-ground of Tailten, the graves of the Royal Ultonian race. This Academy, in its Proceedings,[1] 12th February, 1872, has figured all

[1] Proc., 2nd Ser., Polite Lit. and Antiq., Vol. i., p. 72.

the scribed stones found within this special Cairn in small wood-cuts, and also the "Hag's Chair," a conspicuous stone situated on the brow of the hill in front of the great Cairn T. The Academy obtained, through Mr. Conwell, from Mr. Naper of Lough Crew, owner of the land, all the objects found in his explorations. As these are fully described and safely preserved in the Museum, it is unnecessary for me to do more than recall the fact. Steps were also taken for publishing in our Transactions a full account of the rest of these Cairns, for four rude lithographic plates were executed. These, I am happy to assure our Members, never appeared, as they would have reflected little credit on us so far as artistic appearance goes. It would be needless to acknowledge the debt we owe to Mr. Conwell for his discovery and investigation of this series of Cairns—by far the most important antiquarian discovery of inscribed prehistoric monuments ever made in Great Britain or Ireland—or for the commendable care with which he had the strange graven marks found upon the stones recorded. Stones inscribed in a similar manner, though comparatively few in number, have been long known in the Cairns of New Grange and Dowth; but we must go to France, to the Tumulus of Gavr Inis, to find any prehistoric monument of equal importance to these Cairns on the Lough Crew Hills; not from their size, for Dowth and New Grange are, in this respect, of premier rank, but for the multiplicity of stones bearing scribings, and to the amount of markings they contain.

The Government of France have published good and reliable engravings of the inscribed stones found on the Cairn at Gavr Inis, and we can compare them with our own series. If it were not for the discovery of these drawings made for Mr. Conwell by Du Noyer, they might have again been forgotten; and I consider it a piece of singular good fortune that they came into my possession after being lost for several years.

The fidelity of Du Noyer in sketching archæological remains is well known: he was an artist of considerable ability; he was, further, a skilful and discriminating antiquary, and subordinated his artistic talents to a literal representation of what he saw before him. It is this which makes his drawings so valuable, constituting them reliable records in the present instance of scribings liable to destruction from exposure to weathering and neglect; or worse still, to the risk of injury from ignorant and careless visitors—the greatest enemies of such easily destroyed objects.

This Academy has received from Mr. Du Noyer many valuable gifts. He completed in the intervals of his laborious occupation on

the Geological Survey an extensive collection of drawings, sufficient to fill twelve folio volumes, which he presented to us. They form a body of Irish Antiquarian Literature priceless for reference and consultation, and constitute a special feature in our Library. I wish we could publish in an appropriate manner this collection which I have much pleasure in exhibiting of the Lough Crew inscribed stones, illustrated, as far as possible, by Mr. Conwell's descriptions. Whether the Cairn T which he described so fully be the Tomb of Ollahm Fodhla, or the lesser Cairns grouped around are the resting places of the Royal Ultonian race, signifies little. The identification of the site itself with Tailten and its historic fair is a matter altogether of opinion, and must be approached in a different form of discussion. We have a plain duty to perform by endeavouring to place on permanent record this series of scribed stones rivalling the great monument of Brittany at Gavr Inis, and surpassing all other remains of a similar character yet discovered in Ireland. Let posterity, if they are able, decipher the true meaning of such elaborate scribings, and unravel the lost history of the race by whom they were produced, and who they were that buried their dead in such remarkable tombs.

XLI.

NOTE ON MEDALS OF ST. VERGIL AND ST. RUDBERT, STRUCK AT SALZBURG. By W. FRAZER, F.R.C.S.I.

[Read April 28, 1890.]

The Bishop of Down and Connor, on February 23, 1863, read a communication, published in our *Proceedings* (vol. viii., p. 295), upon "Two Irish Missionary Saints of the Seventh Century," and exhibited a silver crown piece of Salzburg of the year 1668, which bore the names of two distinguished Irish missionaries, Saints Vergil and Rudbert. Saint Rudbert, or Rupert, whose name Colgan supposed to be a German form of Robaprach, went to Germany from Western Europe, and died at Salzburg, March 27, 718. Vergelius, a celebrated philosopher known by the appellation Solivagus, went from Ireland to Germany about the year 770, and became Bishop of Salzburg. His death is noted in the *Annals of Ulster* to have occurred A.D. 788, and the "Four Masters," under A.D. 784, more fully record the event:—"Fergil, that is the Geometer, Abbot of Achadbo and Bishop of Salzburg, died in Germany in the thirteenth year of his Episcopate." "He was canonized A.D. 1233, by Pope Gregory IX.," and his festival is the 27th of November.

In connexion with St. Rudbert I desire to exhibit a small square silver medal, with loop for suspension, having on one side the arms of the then Prince Bishop of Salzburg, Maximilian Gandolph, which was struck in the year 1669. On the opposite side of the medal is a figure of a seated bishop, with crook and mitre, holding a globe, and inscribed, "S. RVDBERTVS EPIS SALISB 1669," which was struck a year subsequent to the crown-piece recorded by the Bishop of Down and Connor The figures ($\frac{1}{8}$) underneath the seated bishop show that it was intended for a coin as well as a medal.

Of greater interest is a large and much finer medal, struck A.D. 1628, which commemorates the transference of the relics of Saints Rudbert and Vergil, on the 24th September, to the newly erected cathedral of Salzburg, inscribed, "SS RVPERTVS ET VERGILIVS PATRONI TRANSFERVNTVR 24 SEPT." There are four bishops, robed, accompanying

the relics, and carrying them in a reliquary supported on long poles: they bear short episcopal staves ending in open horse-shoe terminations. Indications of four more bishops supporting the opposite side of the poles are visible; and underneath the reliquary are children, with censers, burning incense. The reverse of the medal displays two bishops fully attired (three-quarter lengths) bearing up the new cathedral, with the date 16–28 at its side, and underneath the armorial bearings of the Bishop of Salzburg, the inscription being, "25 SEPT A PARIDE ARCHIE ECCLES METROP SALISB DEDICATVR," the church being dedicated on the day subsequent to the transference of the relics.

It appears desirable to record these medals in honour of distinguished Irish missionaries, as a supplement to the Paper already published in our *Proceedings* by the Bishop of Down and Connor.

XLII.

REPORT ON THE FISHES OBTAINED OFF THE SOUTH-WEST COAST OF IRELAND DURING THE CRUISES OF THE "LORD BANDON" AND THE "FLYING FALCON," 1886 AND 1888. By R. F. SCHARFF, B. Sc., Ph. D., M. R. I. A.

[Read May 12, 1890.]

1886.

The Expedition of 1886 was rather barren in its results as regards Fishes. The only noteworthy captures were the Fork-beard (*Phycis blennioides*, Brünn) and *Sebastes dactyloptera* (de la Roche). The latter has recently been described by Dr. Günther as new to the British Fauna (*Ann. and Mag. Nat. Hist.*, 6th series, vol. 4). I have since re-examined the numerous specimens in the Dublin Museum collection of what was hitherto believed to be *Sebastes norvegicus*, and find that they all agree with the description of *Sebastes dactyloptera*. Therefore it is a well-known form off the West coast of Ireland, whilst the genuine *Sebastes norvegicus* has never been obtained off the Irish coast.

Of the Fork-beard, which belongs to the cod family, only a few specimens had previously been obtained from Irish waters.

The following is a complete list of the species obtained during the expedition of 1886 :—

Sebastes dactyloptera, de la Roche. One adult and two young specimens.

Long-spined Bull-head—*Cottus bubalis*, Euphr. One young specimen from Station 26; another without special mention of locality.

Common Dragonet—*Callionymus lyra*, L. One young specimen from Station 26.

Butter-fish—*Centronotus gunellus*, L. Two young specimens.

Whiting—*Gadus merlangus*, L. One young specimen (Station 50), with two small parasitic crustaceans adhering to the head.

Whiting Pout—*Gadus luscus*, Willughby. One young specimen.

Fork-beard—*Phycis blennioides*, Brünn. Three specimens.

Three-bearded Rockling—*Motella tricirrata*, Bl. Three young specimens from Valentia harbour.

Five-bearded Rockling—*Motella mustela*, L. One young specimen.

Whiff—*Rhombus megastoma*, Donov. One young specimen.

Scald-fish—*Arnoglossus laterna*, Walb. One specimen from Station 3.

Plaice—*Pleuronectes platessa*, L. One young specimen from Station 26.

Dab—*Pleuronectes limanda*, L. One young specimen from Station 40.

Smooth Dab—*Pleuronectes microcephalus*, Donov. One young specimen.

Worm Pipe-fish—*Nerophis lumbriciformis*, Willugh. One specimen.

1888.

The greatest depth reached in the expedition of 1888 was 1080 fathoms; and the result was very gratifying. A specimen of one of the most typical deep-sea families of fishes (Alepocephalidæ) was brought up in the trawl. Another interesting form (Stomias) discovered, is a beautiful example of a deep-sea fish with luminous organs. These organs, which are present in two rows of eye-like spots, have been minutely described by Lendenfeld in Dr. Günther's Report on the Deep-sea Fishes collected by the *Challenger* expedition. Dr. Günther believes that, in the more specialized luminous organs, production of light is subject to the will of the fish, and that they are used by them as "bull's-eyes." Deep-sea fishes, such as Macrurus, of which also a specimen has been obtained, have their muciferous system well developed; and as they have no luminous organs, it is supposed that the mucus of the fish supplies the luminosity. The Stomias, referred to above, possess a barbel, tipped with a diffuse patch of luminous substance which, according to Dr. Günther, may act as a lure to other fishes.

Most of the deep-sea fishes are either black, pink, or silvery.

One littoral species of fish (Gobius) is new to science, and the species of Haloporphyrus is new to the Irish deep-sea Fauna.

The following fishes were collected :—

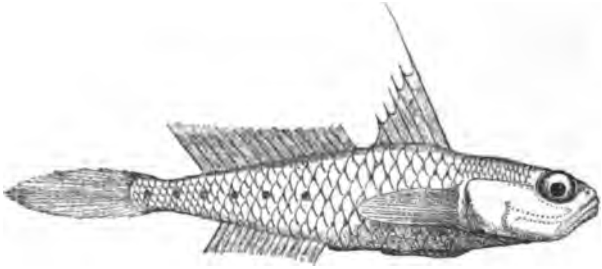
Red Gurnard—*Trigla cuculus*, Bloch. One half-grown specimen from 33 fathoms, Station 2, and another from 24 fathoms, Station 71.

Common Dragonet—*Callionymus lyra*, L. One adult male specimen from 24 fathoms, Station 71, and a young one from 33 fathoms, Station 2.

Freckled Goby—*Gobius minutus*, L. One specimen from 24 fathoms, Station 71, and another from 5 fathoms, Station 70.

Gobius macrolepis, nov. spec.

D. 6 | 15. A. 15. P. 16. C. 3 | 18 | 3.



The length of the head is one-fourth of the total length of the body (without caudal fin). Eye, one-third of the length of the head. The width of the interorbital space equals one-fifth of the diameter of the eye. Scales large and deciduous; eight in a transverse row between the first dorsal and the commencement of the anal fin. The first ray of first dorsal filiform; caudal fin pointed. Stripes of minute warts on the side of the head; throat scaleless.

The colour of the specimen in the spirit is light-brown, with a yellow tinge on the under side of the body. There are a few dark spots on the lateral line.

A single specimen of this species was obtained in 5 fathoms (Station 70) on the S.-W. coast of Ireland. Total length 78 m.m. to the root of the caudal 61, length of head 17.

This species somewhat resembles the Mediterrànean *Gobius jozo*, L., but differs from it in the shape of the head, the larger scales and more numerous fin rays. The Norwegian *Gobius scorpioides*, Collett (*Forh. Vidensk. Selsk.*, Christiania, 1874), has the large scales and shape of the head in common with *G. macrolepis*, but the latter is much larger and differs in the shape of the caudal fin and the number of fin rays, &c.

Fifteen-spined Stickleback—*Gasterosteus spinachia*, L. One specimen from 4 fathoms, Long Island Sound.

Haddock—*Gadus aeglefinus*, L. One young specimen from 5 fathoms, Station 70.

Poor Cod—*Gadus minutus*, L. One half-grown specimen from 24 fathoms, Station 71.

Hake—*Merluccius merluccius*, L. One half-grown specimen from 50 fathoms, Station 75.

Haloporphyrus eques, Günther. One specimen 12½ in. long, from 750 fathoms, Station 69. Specimens of this fish have been obtained by the *Knight Errant*, in the Faroë Channel, in 530 fathoms.

Macrurus coelorhynchus, Risso. One specimen from 345 fathoms, Station 67. This is a common Mediterranean deep-sea fish; but it has also been obtained at Madeira; and Collett believes that a specimen found in the stomach of a cod, near Bergen, belongs to this species.

Scald Fish—*Arnoglossus laterna*, Walb. Two specimens from 33 fathoms, Station 2, and one from 24 fathoms, Station 71.

Variegated Sole—*Solea variegata*, Donov. One specimen from 50 fathoms, Station 75.

Stomias (sp.?).

Two small deep-sea fishes, from 1080 fathoms, belong to the genus Stomias. There is a double row of about 80 luminous spots between the head and the caudal fin. These are too young for specific identification; but they undoubtedly belong to the genus Stomias. A species closely resembling these two specimens has been known for some time from the Mediterranean, and is figured in Cuvier and Valencienne's *Hist. Nat. des Poissons.*

Bathytroctes (?).

One specimen, from 1080 fathoms, Station 68, I referred to a new genus, owing to the complete absence of scales. However, Dr. Günther, to whom I submitted this and the two last-mentioned specimens, considers it too young for specific or generic determination.

I have since re-examined it, and found no trace of reproductive organs, so that it may be assumed that the specimen is an immature fish, which at present cannot, with certainty, be referred to any particular genus. There is no doubt that it belongs to the typical deep-sea family, Alepocephalidæ.

XLIII.

REPORT ON THE FORAMINIFERA OBTAINED OFF THE SOUTH-WEST OF IRELAND DURING THE CRUISE OF THE "FLYING FALCON," 1888. By JOSEPH WRIGHT, F.G.S. (Plate XX.)

[Read April 28, 1890.]

In May, 1888, an expedition left Queenstown on board the steam-tug "Flying Falcon," with the object of exploring the deep-sea Fauna off the west coast of Ireland. It was the third expedition that had been sent out by the Royal Irish Academy, the others having taken place in the years 1885 and 1886. The object of this third cruise was to obtain specimens from still greater depths, and in this respect it was fairly successful, and would have been even more so had it not been for the stormy weather which prevailed during the greater part of the time. Only six of the gatherings which were obtained yielded Foraminifera, and of these only three had portions of the sea bottom brought up by the dredge; the others merely consisted of very small samples (log 4) from sounding apparatus, and (logs 5 and 6) from the stomachs of Holothuria.

To Robert Welch, Esq., I am much indebted for the very accurate and artistic drawings of the Foraminifera accompanying this Report (Plate xx.). My thanks are also due in an especial manner to A. J. Hollick, Esq., for his care and skill in transferring them to stone. Mr. Hollick has had in all cases the original specimens before him.

Log 4.—Lat. 50° 52′ N.; long. 11° 27′ W.; depth, 1020 fathoms. Globigerina ooze.

About one ounce of Globigerina ooze from sounding machine, the Foraminifera consisting largely of Globigerina, Pulvinulina, and Orbulina. The following species were abundant:—Sigmöilina

celata, Trochammina robertsoni, Bulimina inflata, Bolivina decussata, Uvigerina aculeata, U. angulosa, Rotalia orbicularis, and Truncatulina wuellerstorfi.

Log 5.—Lat. 51° 1′ N.; long. 11° 50′ W.; depth, 750 fathoms. Mud from stomach of Holothuria.

About two ounces of mud, largely composed of Foraminifera, especially of the following genera:—Bolivina, Lagena, Globigerina, Orbulina, and Pulvinulina. The following were the most prominent species:—Sigmöilina celata, Rhabdammina abyssorum, Haplophragmium glomeratum, Webbina clavata, Gaudryina pupoides, Rhabdagonium tricarinatum, Uvigerina angulosa, Nonionina umbilicatula and N. turgida.

Log 3.—Lat. 51° 2′ N.; long. 11° 27′ W.; depth, 345 fathoms. Fine sand.

A large quantity of fine sand brought up by the dredge. In it were found two specimens of Challengeria, and a number of Foraminifera of the following genera:—Bolivina, Lagena, Globigerina, Orbulina, and Pulvinulina. The following species were plentiful:—Astrorhiza arenaria, Haplophragmium pseudospirale, Gaudryina pupoides, Rhabdogonium tricarinatum, Uvigerina angulosa, U. asperula, and Nonionina turgida.

Log 8.—Eleven miles south of Glandore Harbour; depth, 53 fathoms. Muddy sand and small shells.

Foraminifera plentiful, chiefly of the following genera:—Spiroloculina, Miliolina, Haplophragmium, Bigenerina, Bulimina, Bolivina, Lagena, and Uvigerina; Planispirina contraria was frequent.

Log. 9.—Depth, 50 fathoms. Mud from stomach of Holothuria.

A very small quantity of mud containing very few Foraminifera.

Log. 6.—Berehaven Harbour; depth, 7 fathoms. Mud.

Shallow-water forms of Foraminifera, plentiful. It contained Spiroloculina acutimargo, Miliolina labiosa, and Lagena inæquilateralis.

Sub-kingdom, **PROTOZOA.**

Class, **Rhizopoda.**

Order, FORAMINIFERA—(RETICULARIA).

Family, MILIOLIDÆ.

Sub-family, MILIOLININÆ.

BILOCULINA, d'Orbigny.

Biloculina irregularis, d'Orbigny.

Biloculina irregularis, d'Orbigny, 1839, Foram. Amér. Mérid., p. 67, pl. viii. figs. 22–24.

Very rare at 345 fathoms and 750 fathoms.

Biloculina sphæra, d'Orbigny.

Biloculina sphæra, d'Orbigny, 1839, Foram. Amér. Mérid., p. 66, pl. viii. figs. 13–16.

Very rare at 53–750 fathoms.

Biloculina bulloides, d'Orbigny.

Biloculina bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 297, No. 1, pl. xvi. figs. 1–4; Modèle No. 90.

Very rare at 345–1020 fathoms.

Biloculina ringens, Lamarck, sp.

Miliolites ringens, Lamarck, 1804, Ann. du Muséum, vol. v. p. 351; vol. ix. pl. xvii. fig. 1.

Frequent at 7 fathoms and 53 fathoms; rare at 345 fathoms and 750 fathoms.

Biloculina ringens, *var.* elongata, d'Orbigny.

Biloculina elongata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 4.

Very rare at 345 fathoms.

Biloculina depressa, d'Orbigny.

Biloculina depressa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 298, No. 7; Modèle, No. 91.

Frequent in shallow water; very rare at 345 fathoms.

Biloculina depressa, *var.* murrhyna, Schwager.

Biloculina murrhyna, Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 203, pl. vi. figs. 15, a–c.

At 750 fathoms and 1020 fathoms.

SPIROLOCULINA, d'Orbigny.

Spiroloculina planulata, Lamarck, sp.

Miliolites planulata, Lamarck, 1805, Ann. du Muséum, vol. v. p. 352, No. 4.

At 7 fathoms and 53 fathoms.

Spiroloculina limbata, d'Orbigny.

Spiroloculina limbata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 299, No. 12.

Common at 53 fathoms.

Spiroloculina tenuisepta, Brady.

Spiroloculina tenuisepta, Brady, 1884, "Challenger" Rep., p. 153, pl. x. figs. 5, 6.

Frequent at 7 fathoms and 750 fathoms.

Spiroloculina acutimargo, Brady.

Spiroloculina acutimargo, Brady, 1884, "Challenger" Rep., p. 154, pl. x. figs. 12–15.

A few very small specimens of this species were found at 7 fathoms and 53 fathoms.

Spiroloculina canaliculata, d'Orbigny.

Spiroloculina canaliculata, d'Orbigny, 1846, For. Foss. Vien., p. 269, pl. xvi. figs. 10–12.

Frequent at 7 fathoms and 53 fathoms.

MILIOLINA, Williamson.

Miliolina seminulum, Linné, sp.

Serpula seminulum, Linné, 1767, Syst. Nat., 12th ed., p. 1264, No. 791.

Common in Berehaven Harbour, 7 fathoms; rare at 53 fathoms.

Miliolina auberiana, d'Orbigny, sp.

Quinqueloculina auberiana, d'Orbigny, 1839, Foram. Cuba, p. 167, pl. xii. figs. 1–3.

Forms of *Miliolina* resembling *auberiana* were frequent in nearly all the deep-water gatherings taken off the west of Ireland in the cruises of the "Lord Bandon" and of the "Flying Falcon"; they appear to be closely allied to *M. seminulum*, and may be after all but a form of that species.

Miliolina contorta, d'Orbigny, sp.

Quinqueloculina contorta, 1846, For. Foss. Vien., p. 298, pl. xx. figs. 4–6.

Dr. Brady considers it probable that the British specimens assigned provisionally to *Miliolina sclerotica* and *Miliolina contorta* belong in reality to the same species.

Common at Berehaven Harbour, 7 fathoms; rare at 53 fathoms.

Miliolina labiosa, d'Orbigny, sp.

Triloculina labiosa, d'Orbigny, 1839, Foram. Cuba, p. 157, pl. x. figs. 12–14.

Frequent at 7 fathoms and 53 fathoms; specimens small.

Miliolina subrotunda, Montagu, sp.

Vermiculum subrotundum, Montagu, 1803, Test. Brit., pt. 2, p. 521.

Very rare at 53 to 345 fathoms; common at Berehaven Sound, 7 fathoms.

Miliolina ferussacii, d'Orbigny, sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 301, No. 18; Modèle, No. 32.

Rare; 7 fathoms and 53 fathoms.

Miliolina bicornis, Walker and Jacob, sp.

Serpula bicornis, Walker and Jacob, 1798, Adams' Essays, Kanmacher's ed., p. 633, pl. xiv. fig. 2.

Rare; 7 fathoms and 53 fathoms.

Miliolina agglutinans, d'Orbigny, sp.

Quinqueloculina agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 168, pl. xii. figs. 11–13.

A single specimen at 345 fathoms.

SIGMÖILINA, Schlumberger.

Sigmöilina celata, Costa, sp.

Spiroloculina celata, Costa, 1855, Mem. Accad. Napoli., vol. ii. p. 126, pl. i. fig. 14.

Frequent; 50–1020 fathoms.

Sigmöilina tenuis, Czjzek, sp.

Quinqueloculina tenuis, Czjzek, 1847, Haidingers, Naturw. Abhandl., vol. ii. p. 149, pl. xiii. figs. 31–34.

Found in all the gatherings.

PLANISPIRINA, Seguenza.

Planispirina contraria, d'Orbigny, sp.

Biloculina contraria, d'Orbigny, 1846, For. Foss. Vien., p. 262, pl. xvi. figs. 4–6.

Common at 53 fathoms.

OPHTHALMIDIUM, Kübler.

Ophthalmidium inconstans, Brady.

Hauerina inconstans, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. (N.S.) p. 54; Ophthalmidium inconstans, Id. 1844, "Challenger" Rep., p. 189, pl. xii. figs. 5, 7, 8.

Two specimens found at 750 fathoms.

Ophthalmidium carinatum, Balkwill and Wright.

Ophthalmidium carinatum, Balkwill and Wright, 1885, Trans. Roy. Irish Acad., vol. xxviii. (Science) p. 326, pl. xii. figs. 13–16.

Dr. Brady, in his Synopsis of "British Recent Foraminifera," has given this form as a synonym of the preceding species. I am, however, inclined to regard them as sufficiently distinct for separate binomial terms. *O. carinatum* differs from *O. inconstans* in its much smaller size, and in its having septate chambers throughout its entire growth; the contour of the chambers is also dissimilar.

It has been found at many places around the Irish Coast both in dredgings and shore gatherings, but is rare where it occurs, seldom more than one or two specimens being met with at any one place. Typical examples of both *O. carinatum* and *O. inconstans* were found at log 5, 750 fathoms.

Very rare; 7 fathoms and 750 fathoms.

Sub-family, PENEROPLIDINÆ.

CORNUSPIRA, Schultze.

Cornuspira foliacea, Philippi, sp.

Orbis foliaceus, Philippi, 1844, Enum. Moll. Sicil., vol. ii. p. 147, pl. xxiv. fig. 26.

Very rare at 7 fathoms.

Cornuspira involvens, Reuss.

Operculina involvens, Reuss, 1849, Denkschr. d. K. Akad. Wiss. Wien, vol. i. p. 370, pl. xlv. fig. 20.

Rare ; 7 fathoms and 750 fathoms.

Cornuspira carinata, Costa, sp.

Operculina carinata, Costa, 1856, Atti dell' Accad. Pont., vol. vii. p. 209, pl. xvii. fig. 15.

Rare ; 53 fathoms and 345 fathoms.

Family, Astrorhizidæ. *Sub-family*, Astrorhizinæ.

ASTRORHIZA, Sandahl.

Astrorhiza arenaria, Norman.

Astrorhiza arenaria, Norman, 1876, Proc. Roy. Soc., vol. xxv. p. 213.

Common at 345 fathoms.

Sub-family, Saccammininæ.

PSAMMOSPHÆRA, Schulze.

Psammosphæra fusca, Schulze.

Psammosphæra fusca, Schulze, 1874, II. Jahresberichte d. Komm. Unters. d. deutsch. Meere. in Kiel, p. 113, pl. ii. fig. 8.

Rare at 750 fathoms.

Sub-family, Rhabdammininæ.

HYPERAMMINA, Brady.

Hyperammina elongata, Brady.

Hyperammina elongata, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 2.

Rare ; 750 fathoms and 1020 fathoms.

Hyperammina elongata, *var.* lævigata, Nov. (Plate xx. Fig. 1).

Test very finely arenaceous, smooth and polished, of a rich brown colour, and usually with a fusiform primordial end.

Rare at 345 fathoms.

MARSIPELLA, Norman.

Marsipella elongata, Norman.

Marsipella elongata, Norman, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 281, pl. xvi. fig. 7.

Very rare at 750 fathoms.

RHABDAMMINA, M. Sars.

Rhabdammina abyssorum, M. Sars.

Rhabdammina abyssorum, M. Sars, 1868, Vidensk.-Selsk. Forhandl., 1868, p. 248.

Frequent at 750 fathoms.

Family, LITUOLIDÆ. *Sub-family*, LITUOLINÆ.

REOPHAX, Montfort.

Reophax difflugiformis, Brady.

Reophax difflugiformis, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. (N. S.) p. 51, pl. iv. fig. 3, a. b.

Very rare; 345 fathoms and 750 fathoms.

Reophax fusiformis, Williamson, sp.

Proteonina fusiformis, Williamson, 1858, Rec. For. Gr. Br., p. 1, pl. i. fig. 1.

Common; 7–53 fathoms.

Reophax scorpiurus, Montfort.

Reophax scorpiurus, Montfort, 1808, Conchyl. Systém., vol. i. p. 330, 83[e] genre.

Rare; found in all the gatherings.

Reophax guttifera, Brady.

Reophax guttifera, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 49.

Rather rare; 345 fathoms and 750 fathoms.

HAPLOPHRAGMIUM, Reuss.

Haplophragmium pseudospirale, Williamson, sp.

Proteonina pseudospiralis, Williamson, 1858, Rec. For. Gr. Br., p. 2, pl. i. figs. 2, 3.

Frequent; 7–53 fathoms; a single specimen very small in size at 345 fathoms.

Haplophragmium canariense, d'Orbigny, sp.

Nonionina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. ii. figs. 33, 34.

Frequent; 7–750 fathoms.

Haplophragmium globigeriniforme, Parker and Jones, sp.

Lituola nautiloidea, *var.* globigeriniformis, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 407, pl. xv. figs. 46, 47, &c.

Rather rare; 7–345 fathoms.

Haplophragmium glomeratum, Brady.

Lituola glomerata, Brady, 1878, Ann. and Mag. Nat. Hist., ser. 5, vol. i. p. 433, pl. xx. fig. 1, a. b. c.

Frequent; 7–750 fathoms.

Sub-family, Trochamminінæ.

PLACOPSILINA, d'Orbigny.

Placopsilina cenomana, d'Orbigny.

Placopsilina cenomana, d'Orbigny, 1850, Prodr. Paleont., vol. ii. p. 185, No. 758.

Very rare at 345 fathoms.

THURAMMINA, Brady.

Thurammina papillata, Brady.

Thurammina papillata, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. (N. S.) p. 45, pl. v. figs. 4–8.

Very rare; 345–1020 fathoms.

HORMOSINA, Brady.

Hormosina globulifera, Brady.

Hormosina globulifera, Brady, 1879, Quart. Journ. Micr. Sci., vol. xix. (N. S.) p. 60, pl. iv. figs. 4, 5.

One specimen at 750 fathoms.

AMMODISCUS, Reuss.

Ammodiscus incertus, d'Orbigny, sp.

Operculina incerta, d'Orbigny, 1839, Foram. Cuba, p. 71, pl. vi. figs. 16, 17.

Rare at 53 fathoms.

Ammodiscus gordialis, Jones and Parker, sp.

Trochammina squamata gordialis, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Very rare; 50–345 fathoms.

Ammodiscus charoides, Jones and Parker, sp.

Trochammina squamata charoides, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Very rare; 53 fathoms and 345 fathoms.

TROCHAMMINA, Parker and Jones,

Trochammina squamata, Jones and Parker.

Trochammina squamata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

Frequent at 7 fathoms; very rare at 53 fathoms.

Trochammina plicata, Terquem, sp.

Patellina plicata, Terquem, 1876, Anim. Sur. la Plage de Dunkerque 2[me] fasc., p. 72, pl. viii. fig. 9.

Rare at 7 fathoms.

Trochammina inflata, Montagu, sp. *var*.

Nautilus inflatus, Montagu, 1808, Test. Brit., Suppl., p. 81, pl. xviii. fig. 3; Trochammina inflata, Balkwill and Wright, 1885, Trans. Roy. Irish Acad., vol. xxviii. (Science) p. 331, pl. xiii. figs. 11, 12.

Very rare; 345 fathoms and 1020 fathoms.

Trochammina nitida, Brady.

Trochammina nitida, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 52.

Rare; 53–750 fathoms.

Trochammina robertsoni, Brady. (Plate xx. Figs. 4 a, 4 b.)

Trochammina robertsoni, Brady, 1887, Journ. Roy. Micr. Soc., p. 893.

Found in all the gatherings; common at 53 fathoms and 1020 fathoms.

WEBBINA, d'Orbigny.

Webbina clavata, Jones and Parker. (Pl. xx. figs. 2, 3.)

Trochammina irregularis clavata, Jones and Parker, 1860, Quart. Journ. Geol. Soc., vol. xvi. p. 304.

In this species when the adherent chamber is of large size the tubular portion is short, but when it is small the tubular portion is usually extended to a considerable length. A somewhat similar mode of growth appears largely to prevail among the Foraminifera generally, as individuals with large primordial chambers have, as a rule, fewer segments than those in which it happens to be small. At 750 fathoms the species was met with in considerable numbers, the tubular portion being often very long, and having attached to it minute rounded fragments of quartz, of very uniform size, arranged alternately in a pretty chain-like pattern.

Sub-family, LOFTUSINÆ.

CYCLAMMINA, Brady.

Cyclammina cancellata, Brady.

Cyclammina cancellata (Brady, M.S.), Norman, 1876, Proc. Roy. Soc., vol. xxv. p. 204.

Rare at 345 fathoms.

Family, TEXTULARIDÆ. *Sub-family*, TEXTULARINÆ.

TEXTULARIA, Defrance.

Textularia agglutinans, d'Orbigny.

Textularia agglutinans, d'Orbigny, 1839, Foram. Cuba, p. 136, pl. i. figs. 17, 18, 32–34.

Very rare; 50–345 fathoms.

Textularia gramen, d'Orbigny.

Textularia gramen, d'Orbigny, 1846, For. Foss. Vien., p. 248, pl. xv. figs. 4–6.

Frequent at 345 fathoms.

Textularia concava, Karrer, sp.

Plecanium concavum, Karrer, 1868, Sitzungst. d. k. Ak. Wiss. Wien, vol. lviii. p. 129, pl. i. fig. 3.

Rare; 7–345 fathoms.

Textularia globulosa, Ehrenberg.

Textularia globulosa, Ehrenberg, 1839, Abhandl. Akad. Berlin (1838), p. 135, No. 60, pl. iv.; several figures.

A single specimen at 345 fathoms.

SPIROPLECTA, Ehrenberg.

Spiroplecta sagittula, Defrance, sp.

Textularia sagittula, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177; vol. liii. p. 344; Atlas Conch., pl. xiii. fig. 5.

Spiroplecta sagittula is frequent around the Irish coast, but not so plentiful as the closely allied form *Textularia gramen*. As this species is almost invariably dimorphous, the early chambers having a spiral arrangement, I have placed it in the genus Spiropleeta. In most cases the spiral is fairly well developed, the distal end being round in contour, and the lateral edges nearly parallel; at times the spiral is very small, and when such is the case, the shell increases more rapidly in size.

Frequent; 7–345 fathoms.

BIGENERINA, d'Orbigny.

Bigenerina digitata, d'Orbigny.

Bigenerina (Gemmulina) digitata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 262, No. 4; Modèle, No. 58.

Rare at 7 fathoms and 50 fathoms; very common at 53 fathoms.

Bigenerina nodosaria, d'Orbigny.

Bigenerina nodosaria, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 261, No. 1, pl. xi. figs. 9–12; Modèle, No. 57.

Rare at 53 fathoms and 750 fathoms.

GAUDRYINA, d'Orbigny.

Gaudryina pupoides, d'Orbigny.

Gaudryina pupoides, d'Orbigny, 1840, Mém. Soc. Géol. France, vol. iv. p. 44, pl. iv. figs. 22–24.

Common at 345 fathoms and 750 fathoms.

Gaudryina filiformis, Berthelin.

Gaudryina filiformis, Berthelin, 1880, Mém. Soc. Géol. France, Sér. 3, vol. i. No. 5, p. 25, pl. i. fig. 8.

Rare at 50–345 fathoms; frequent at 7 fathoms and 1020 fathoms.

VERNEUILINA, d'Orbigny.

Verneuilina polystropha, Reuss, sp.

Bulimina polystropha, Reuss, 1845, Verstein. Böhm. Kreid, pt. 2, p. 109, pl. xxiv. fig. 53.

Frequent at 7–53 fathoms.

Verneuilina spinulosa, Reuss.

Verneuilina spinulosa, Reuss, 1849, Denkschr. d. K. Akad. Wiss. Wien., vol. i. p. 347, pl. xlvii. fig. 12, a.–c.

A single specimen at 750 fathoms.

Verneuilina pygmæa, Egger, sp.

Bulimina pygmæa, Egger, 1857, Neues Jahrb. für min., p. 284, pl. xii. figs. 10, 11.

Rare at 750 fathoms and 1020 fathoms.

VALVULINA, d'Orbigny.

Valvulina conica, Parker and Jones.

Valvulina triangularis, *var.* conica, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 406, pl. xv. fig. 27.

Rare at 750 fathoms.

Valvulina fusca, Williamson, sp.

Rotalina fusca, Williamson, 1858, Rec. For. Gr. Br., p. 55, pl. v. figs. 114, 115.

Rare at 50–750 fathoms.

Sub-family, Bulimininæ.

BULIMINA, d'Orbigny.

Bulimina elegans, d'Orbigny.

Bulimina elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 270, No. 10; Modèle, No. 9.

Rare at 345 fathoms.

Bulimina pyrula, d'Orbigny.

Bulimina pyrula, d'Orbigny, 1846, For. Foss. Vien., p. 184, pl. xi. figs. 9, 10.

Frequent at 345 fathoms.

Bulimina ovata, d'Orbigny.

Bulimina ovata, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 13, 14.

Frequent at 7-1020 fathoms.

Bulimina affinis, d'Orbigny.

Bulimina affinis, d'Orbigny, 1839, Foram. Cuba, pl. ii. figs. 25, 26.

Rare at 750 fathoms.

Bulimina pupoides, d'Orbigny.

Bulimina pupoides, d'Orbigny, 1846, For. Foss. Vien., p. 185, pl. xi. figs. 11, 12.

Found in all the gatherings; rare in deep water; very common at 7 fathoms.

Bulimina fusiformis, Williamson.

Bulimina pupoides, *var.* fusiformis, Williamson, 1858, Rec. For. Gr. Br., p. 63, pl. v. figs. 129, 130.

Found in all the gatherings; frequent at 50–1020 fathoms; very common at 7 fathoms.

Bulimina elegantissima, d'Orbigny.

Bulimina elegantissima, d'Orbigny, 1839, Foram. Amér. Mérid., p. 51, pl. vii. figs. 13, 14.

Very rare at 1020 fathoms; frequent at 7 fathoms.

Bulimina subteres, Brady.

Bulimina presli, *var.* elegantissima, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 374, pl. xv. figs. 12–17.

Bulimina subteres, Brady, 1881, Quart. Jour. Micr. Sci., vol. xxi. (N. S.) p. 55.

Bulimina pupoides, *var.* convoluta, Williamson, 1858, Rec. For. Gr. Br., p. 63, pl. v. figs. 132, 133.

Rare at 7–750 fathoms.

Bulimina convoluta I am disposed to regard as an abnormal form of *Bulimina subteres*, and I have therefore given it as a synonym of this species.

Rare; 7–750 fathoms.

Bulimina marginata, d'Orbigny.

Bulimina marginata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, No. 4, pl. xii. figs. 10–12.

Found in all the gatherings; common at 53 fathoms and 345 fathoms.

Bulimina inflata, Seguenza.

Bulimina inflata, Seguenza, 1862, Atti dell Accad. Gioenia, vol. xviii. ser. 2, p. 107, pl. i. fig. 10.

Found at 345–1020 fathoms.

Bulimina buchiana, d'Orbigny.

Bulimina buchiana, d'Orbigny, 1846, For. Foss. Vien., p. 186, pl. xi. figs. 15–18.

Rare; 53–750 fathoms.

VIRGULINA, d'Orbigny.

Virgulina schreibersiana, Czjzek.

Virgulina schreibersiana, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 147, pl. xiii. figs. 18–21.

Frequent; 7–1020 fathoms.

BOLIVINA, d'Orbigny.

Bolivina punctata, d'Orbigny.

Bolivina punctata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 61, pl. viii. figs. 10–12.

Frequent; found in all the gatherings.

Bolivina lævigata, Williamson, sp.

Textularia variabilis, *var.* lævigata, Williamson, 1858, Rec. For. Gr. Br., p. 77, pl. vi. fig. 168.

Bolivina textilarioides, Reuss, 1862, Sitzungsb. d. K. Akad. Wiss. Wien., vol. xlvi., p. 81, pl. x. fig. 1.

Found in all the gatherings; common at 345–1020 fathoms.

Bolivina plicata, d'Orbigny.

Bolivina plicata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 62, pl. viii. figs. 4–7.

Rare; 7–750 fathoms.

Bolivina difformis, Williamson, sp.

Textularia variabilis, *var.* difformis, Williamson, 1858, Rec. For. Gr. Br., p. 77, pl. vi. figs. 166, 167.

Found in all the gatherings; common at 7 fathoms and 53 fathoms.

Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849, Denkschr. d. K. Ak. Wiss. Wien., vol. i. p. 381, pl. xlviii. fig. 15.

Common at 7–750 fathoms.

Bolivina ænariensis, Costa, sp.

Brizalina ænariensis, Costa, 1856, Atti. dell' Accad. Pont., vol. vii. p. 297, pl. xv. fig. 1.

Frequent at 345–1020 fathoms.

Bolivina decussata, Brady.

Bolivina decussata, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 58; "Challenger" Rep., p. 423, pl. liii. figs. 12, 13.

Common at 1020 fathoms.

Bolivina quadrilatera, Schwager, sp.

Textularia quadrilatera, Schwager, 1866, Novara-Exped. Geol. Theil., vol. ii. p. 253, pl. vii. fig. 103.

This well-marked form I have referred to the genus Bolivina, and I may here observe that Bolivina may be readily known from Textularia, not only by the comma-shaped aperture, but also by the shells being of a hyaline texture; in Textularia, with very few exceptions, the shells are more or less arenaceous.

Frequent at 345 fathoms; rare at 750 fathoms; and very rare at 53 fathoms.

Sub-family, CASSIDULININÆ.

CASSIDULINA, d'Orbigny.

Cassidulina lævigata, d'Orbigny.

Cassidulina lævigata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 282, No. 1, pl. xv. figs. 4, 5; Modèle, No. 41.

Found in all the gatherings, and common in most of them.

Cassidulina crassa, d'Orbigny.

Cassidulina crassa, d'Orbigny, 1839, Foram. Amér. Mérid., p. 56, pl. vii. figs. 18–20.

Found in all the gatherings, but not so plentiful as *C. lævigata*; common at 345 fathoms.

Cassidulina bradyi, Norman.

Cassidulina bradyi, (Norman M.S.), Wright, 1880, Proc. Belfast Nat. Field Club (1879–1880), Appendix, p. 152.

Rare at 7–750 fathoms.

Family, Chilostomellidæ.

CHILOSTOMELLA, Reuss.

Chilostomella ovoidea, Reuss.

Chilostomella ovoidea, Reuss, 1849, Denkschr. d. K. Akad. Wiss. Wien., vol. i. p. 380, pl. xlviii. fig. 12.

Frequent at 53 fathoms and 345 fathoms.

SEABROOKIA, Brady.[1]

Test calcareous, free, very finely perforate, thin and transparent, polythalamous; segments few, unequally convex on the upper and under side, either embracing or almost embracing; aperture, a slit, which is alternately at either end of the shell.

[**Seabrookia pellucida**, Brady. (Plate xx. Figs. 5 a, 5 b.)[2]

Seabrookia pellucida, Brady, Jour. Roy. Mic. Soc., Nov., 1890, p. 569, woodcuts, figs. 1, 2.

Test thin and hyaline; segments embracing, ovate, slightly

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[1] When the present Paper was presented, the genus Seabrookia had not been published, and the generic term Millettia, proposed by me at the suggestion of Mr. Earland, in the Annals and Magazine of Natural History for December, 1889, was employed for these species—the one from Java, the other from Cork. Since then, however, Dr. Brady has published the genus Seabrookia for the form from Java, and I have withdrawn the name Millettia in favour of that proposed by Dr. Brady.

[2] The specimen figured Pl. xx., Fig. 5, was in bad condition, and the arrangement of the chambers not distinctly seen. The more perfect specimens figured by Dr. Brady show the early chambers only partially enclose each other, the later ones completely so.

carinate, unequally convex on the upper and under side, aboral ends slightly serrate; aperture a fissure with entosolenian neck occupying the entire width of the narrow end of the segment; chambers usually five to seven in number.

This species has been found at two localities, in both of which it is exceedingly rare, viz. off Cebu, 120 fathoms, and in the Java sea, 45 fathoms. The specimens were sent to me by Mr. Earland.]

Seabrookia earlandi, Wright, sp. (Plate xx. Figs. 6, 7 a, 7 b.)

Millettia earlandi, Wright, 1889, Ann. and Mag. Nat. Hist., ser. 6, vol. iv., p. 448. (Name only.)

Test thin and hyaline; segments nearly embracing, protruding a little near the oral end, ovate, somewhat irregular in shape, slightly carinate, unequally convex on the upper and under sides; aperture a fissure extending the entire width of the narrow end of the segment; chambers usually five in number.

I have much pleasure in naming this species after my friend Mr. Arthur Earland, who first found it in material dredged off Castletown, County Cork. 37½ fathoms ("Lord Bandon" cruise, 1886, log 42).

Not unfrequent at 345 fathoms.

Family, LAGENIDÆ. *Sub-family*, LAGENINÆ.

LAGENA, Walker and Boys.

Lagena globosa, Montagu, sp.

Vermiculum globosum, Montagu, 1803, Test. Brit., p. 523.

Very rare; 7–1020 fathoms.

Lagena apiculata, Reuss.

Oolina apiculata, Reuss, 1850, Haidinger's Naturw. Abhandl., vol. iv. p. 22, pl. i. fig. 1.

Frequent at 1020 fathoms; very rare at 53–750 fathoms.

Lagena botelliformis, Brady.

Lagena botelliformis, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 60; "Challenger" Rep., p. 454, pl. lvi. fig. 6.

Very rare at 750 fathoms.

Lagena lævis, Montagu, sp.

Vermiculum læve, Montagu, 1803, Test. Brit., p. 524.

Rare at 53–1020 fathoms; frequent at 7 fathoms.

Lagena lævis, *var.* clavata, d'Orbigny, sp.

Oolina clavata, d'Orbigny, 1846, For. Foss. Vien., p. 24, pl. i. figs. 2, 3.

Rare at 50–750 fathoms; common at 7 fathoms.

Lagena lævis, *var.* gracillima, Seguenza, sp.

Amphorina gracillima, Seguenza, 1862, Foram. Monotal. Mess., p. 51, pl. i. fig. 37.

Very rare at 345 fathoms and 750 fathoms.

Lagena aspera, Reuss.

Lagena aspera, Reuss, 1861, Sitzungsb. d. K. Ak. Wiss. Wien, vol. xliv. p. 305, pl. i. fig. 5.

One specimen at 7 fathoms.

Lagena hispida, Reuss.

Lagena hispida, Reuss, 1858, Zeitschr. d. deutsch. Geol. Gesell., vol. x. p. 434.

Somewhat rare at 7–1020 fathoms.

Lagena lineata, Williamson, sp.

Entosolenia globosa, *var.* lineata, Williamson, 1858, Rec. For. Gr. Br., p. 9, pl. i. fig. 17.

Very rare at 345 fathoms and 750 fathoms; frequent at 7 fathoms and 53 fathoms.

Lagena striata, d'Orbigny, sp.

Oolina striata, d'Orbigny, 1839, Foram. Amér. Mérid., p. 21, pl. v. fig. 12.

Found in all the gatherings; rare in deep water; common at 7 fathoms and 53 fathoms.

Lagena distoma, Parker and Jones.

Lagena distoma, Brady, 1864, Trans. Linn. Soc. London, vol. xxiv. p. 467, pl. xlviii. fig. 6.

Lagena sulcata, *var.* distoma, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 365, pl. xiii. fig. 20.

Very rare at 345–1020 fathoms.

Lagena gracilis, Williamson.

Lagena gracilis, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 13, pl. i. fig. 5.

Found in all the gatherings; frequent at 750 fathoms.

Lagena sulcata, Walker and Jacob, sp.

Serpula (Lagena) sulcata, Walker and Jacob, 1798, Adam's Essays, Kanmacher's Ed., p. 634, pl. xiv. fig. 5.

Found in all the gatherings; common at 7 fathoms and 53 fathoms,

Lagena williamsoni, Alcock.

Lagena williamsoni, Alcock, 1865, Proc. Lit. and Phil. Soc. Manchester, vol. iv. p. 195.

7–750 fathoms; plentiful in shallow water.

Lagena costata, Williamson, sp.

Entosolenia costata, Williamson, 1858, Rec. For. Gr. Br., p. 9, pl. i. fig. 18.

Lagena costata, Wright, 1877, Proc. Belfast Nat. Field Club, 1876–7, Appendix, p. 103, pl. iv. figs. 11–13.

Rare at 53 fathoms and 750 fathoms.

Lagena semistriata, Williamson.

Lagena striata, *var.* semistriata, Williamson, 1848, Ann. and Mag. Nat. Hist., ser. 2, vol. i. p. 14, pl. i. figs. 9, 10.

Rare at 345 fathoms, and 750 fathoms; rather common at 7 fathoms and 53 fathoms.

Lagena crenata, Parker and Jones.

Lagena crenata, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 420, pl. xviii. fig. 4.

One specimen found at 345 fathoms.

Lagena striatopunctata, Parker and Jones.

Lagena sulcata, *var.* striatopunctata, Parker and Jones, 1865, Phil. Trans., vol. clv. p. 350, pl. xiii. figs. 25–27.

One specimen found at 345 fathoms.

Lagena squamosa, Montagu, sp.

Vermiculum squamosum, Montagu, 1803, Test. Brit., p. 526, pl. xiv. fig. 2.

One specimen at 1020 fathoms; frequent at 7 fathoms and 53 fathoms.

Lagena hexagona, Williamson, sp.

Entosolenia squamosa, *var.* hexagona, Williamson, 1848, Ann. and Mag. Nat. Hist., ser, 2, vol. i. p. 20, pl. ii. fig. 23.

Frequent at 7–1020 fathoms.

Lagena hertwigiana, Brady.

Lagena hertwigiana, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 62; "Challenger" Rep. p. 470, pl. xviii. fig. 36.

Very rare at 750 fathoms.

Lagena lævigata, Reuss. sp.

Fissurina lævigata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlvi. fig. 1.

Found in all the gatherings; common at 53 fathoms.

Lagena lævigata, *var.* lucida, Williamson, sp.

Entosolenia marginata, *var.* lucida, Williamson, 1858, Rec. For. Gr. Br., p. 10, pl. i. figs. 22, 23.

Frequent at 53 fathoms; common at 7 fathoms.

Lagena lævigata, *var.* quadrata, Williamson, sp.

Entosolenia marginata, *var.* quadrata (pars), Williamson, 1858, Rec. For. Gr. Br., p. 11, pl. i. fig. 27; Wright, Belfast Nat. Field Club, 1886, Appendix, pl. xxvi. fig. 9.

Very rare at 53 fathoms and 345 fathoms; frequent at 7 fathoms.

Lagena lævigata, *var.* aperta, Seguenza.

Fissurina aperta, Seguenza, 1862, Foram. Monotal. Mess., p. 60, pl. i. fig. 60.

Lagena faba, Balkwell and Millett, 1884, Journ. Micr. and Nat. Sci., vol. iii. p. 81, pl. ii. fig. 10.

Frequent at 7 fathoms and 53 fathoms.

This small and somewhat obscure form is not unfrequent in shallow water gatherings around the Irish coast.

Lagena fimbriata, Brady.

Lagena fimbriata, Brady, 1881, Quart. Journ. Micr. Sci., vol. xxi. (N. S.) p. 61.

Rare at 7 fathoms and 750 fathoms; frequent at 53 fathoms and 345 fathoms.

Lagena staphyllearia, Schwager, sp.

Fissurina staphyllearia, Schwager, 1866, Novara-Exped., Geol. Theil, vol. ii. p. 209, pl. v. fig. 24.

Rare at 1020 fathoms.

Lagena marginata, Walker and Boys.

Serpula (Lagena) marginata, Walker and Boys, 1784, Test. Min., p. 2, pl. i. fig. 7.

Found in five of the gatherings, 7–1020 fathoms; common at 7 fathoms and 750 fathoms.

Trigonal forms of this species are very rare; a few specimens were found at log 6, 7 fathoms.

Lagena marginata, *var.* inæquilateralis, Wright.

Lagena marginata, *var.* inæquilateralis, Wright, 1886, Proc. Belfast Nat. Field Club, Appendix, p. 321, pl. xxvi. fig. 10, a, b, c.

Rare at 7 fathoms.

Lagena lagenoides, Williamson, sp.

Entosolenia marginata, *var.* lagenoides, Williamson, 1858, Rec. For. Gr. Br., p. 11, pl. i. figs. 25, 26.

Rare at 345 fathoms; frequent at 5 fathoms and 53 fathoms.

Lagena lagenoides, *var.* tenuistriata, Brady.

Lagena tubulifera, *var.* tenuistriata, Brady, 1881, Quart. Journ. Micr. Sci. vol. xxi. (N. S.) p. 61.

Very rare at 7 fathoms and 53 fathoms.

Lagena orbignyana, Seguenza, sp.

Fissurina orbignyana, Seguenza, 1862, Foram. Monotal. Mess., p. 66, pl. ii. figs. 25, 26.

Frequent at 345 fathoms and 750 fathoms; common at 7 fathoms and 53 fathoms.

Lagena orbignyana, *var.* walleriana, Wright. (Plate xx. Figs. 8, 8 b.)

Lagena orbignyana, *var.* walleriana, Wright, 1886, Proc. R. Irish Acad., ser. 2, vol. iv. p. 611.

This variety has the centre of the convex faces ornamented with a rounded boss-like protuberance.

Frequent at 345 fathoms; very rare at 53 fathoms.

It was found frequent in a number of the "Lord Bandon" gatherings.

Lagena orbignyana, *var.* variabilis, Nov. (Plate xx. Figs. 9, 9 b.)

This variety is more elongate in contour than the typical L. orbignyana, and at times has the lower portion of the convex faces ornamented with short riblets, as in the specimen figured.

Frequent at 750 fathoms. I have also met with this variety in several of the "Porcupine" soundings from the North Atlantic.

Lagena bicarinata, Terquem, sp.

Fissurina bicarinata, Terquem, 1882, Mém. Soc. Géol. France, sér. 3, vol. ii. ; Mém. iii. p. 31, pl. i. fig. 24.

Lagena bicarinata, Wright, 1885, Proc. Belfast Nat. Field Club, Appendix, pl. xxvi. fig. 8, a, b.

Very rare at 345 fathoms; frequent at 7 fathoms and 53 fathoms.

Sub-family, NODOSARINÆ.

NODOSARIA, Lamarck.

Nodosaria lævigata, d'Orbigny.

Nodosaria (Glandulina) lævigata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 252, No. 1. pl. x. figs. 1–3.

Frequent at 345 fathoms; very rare at 53 fathoms and 750 fathoms.

Nodosaria rotundata, Reuss, sp.

Glandulina rotundata, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien, vol. i. p. 366, pl. xlvi. fig. 2.

Very rare at 750 fathoms; frequent at 345 fathoms.

Nodosaria calomorpha, Reuss.

Nodosaria calomorpha, Reuss, 1865, Denkschr. d. k. Akad. Wiss. Wien, vol. xxv. p. 129, pl. i. figs. 15–19.

Very rare at 750 fathoms and 1020 fathoms.

Nodosaria pyrula, d'Orbigny.

Nodosaria pyrula, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 253, No. 13 ; Soldani, Testac., vol. ii. p. 35, pl. x. figs. b, c.

Rare at 7–345 fathoms.

Nodosaria farcimen, Soldani, sp.

Orthoceras farcimen, Soldani, 1791, Testaceographia, vol. i. part 2, p. 98, pl. cv. fig. o.

Rare at 750 fathoms.

Nodosaria consobrina, d'Orbigny.

Dentalina consobrina, d'Orbigny, 1846, For. Foss. Vien., p. 46, pl. ii. figs. 1–3.

Very rare at 7–1020 fathoms.

Nodosaria consobrina, *var.* emaciata, Reuss.

Dentalina emaciata, Reuss, 1851, Zeitschr. d. deutsch. Geol. Gesellsch., vol. iii. p. 63, pl. iii. fig. 9.

Rare at 345 fathoms.

Nodosaria soluta, Reuss.

Dentalina soluta, Reuss, 1851, Zeitschr. d. deutsch. Geol. Gesellsch. vol. iii. p. 60, pl. iii. fig. 4, a, b.

Rare at 750 fathoms.

Nodosaria communis, d'Orbigny.

Nodosaria (Dentalina) communis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 254, No. 35.

Rather rare at 7–345 fathoms.

Nodosaria mucronata, Neugeboren.

Dentalina mucronata, Neugeboren, 1856, Denkschr. d. k. Akad. Wiss. Wien, vol. xii. p. 83, pl. iii, figs. 8–11.

Very rare at 7 fathoms, 345 fathoms, and 1020 fathoms.

Nodosaria hispida, d'Orbigny.

Nodosaria hispida, d'Orbigny, 1846, For. Foss. Vien., p. 35, pl. i. figs. 24, 25.

Two very small specimens at 345 fathoms.

Nodosaria scalaris, Batsch., sp.

Nautilus (Orthoceras) scalaris, Batsch, 1791, Conchyl. des Seesandes, No. 4, pl. ii. fig. 4.

Found in all the gatherings; frequent at 53 fathoms and 345 fathoms.

Nodosaria scalaris, *var.* separans, Brady.

Nodosaria scalaris, *var.* separans, Brady, 1884, "Challenger" Rep. p. 511, pl. lxiv. figs. 16–19.

Rare at 345 fathoms; and one small specimen at 7 fathoms.

Nodosaria raphanus, Linné, sp.

Nautilus raphanus, Linné, 1767, Syst. Nat. 12th Ed., p. 1164, 283.

Rare at 345 fathoms; specimens very large.

Nodosaria obliqua, Linné, sp.

Nautilus obliquus, Linné, 1767, Syst. Nat. 12th Ed., p. 1163, 281.

Very rare at 345 fathoms; frequent at 53 fathoms.

LINGULINA, d'Orbigny.

Lingulina carinata, d'Orbigny.

Lingulina carinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 257, No. 1; Modèle, No. 26.

Very rare at 7 fathoms and 53 fathoms.

VAGINULINA, d'Orbigny.

Vaginulina legumen, Linné, sp.

Nautilus legumen, Linné, 1758, Syst. Nat. 10th Ed., p. 711, No. 248.

Very rare at 50–750 fathoms.

Vaginulina linearis, Montagu, sp.

Nautilus linearis, Montagu, 1808, Test. Brit. Supl., p. 87, pl. xxx. fig. 9.

One broken specimen at 50 fathoms.

RHABDAGONIUM, Reuss.

Rhabdagonium tricarinatum, d'Orbigny, sp.

Vaginulina tricarinata, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 258, No. 4; Modèle, No. 4.

Common at 345 fathoms.

MARGINULINA, d'Orbigny.

Marginulina glabra, d'Orbigny.

Marginulina glabra, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 259, No. 6; Modèle, No. 55.

Frequent at 53 fathoms.

Marginulina costata, Batsch, sp.

Nautilus (Orthoceras) costatus, Batsch, 1791, Conchyl. des Seesandes, p. 2, pl. i. fig. 1.

One specimen at 345 fathoms.

Marginulina globosa.

Very rare at 345 fathoms.

CRISTELLARIA, Lamarck.

Cristellaria tenuis, Bornemann, sp.

Marginulina tenuis, Bornemann, 1855, Zeitschr. d. deutsch. Geol. Gessellsch., vol. vii. p. 326, pl. xiii. fig. 14.

Frequent at 345 fathoms.

Cristellaria obtusata, *var.* subalata, Brady.

Cristellaria obtusata, *var.* subalata, Brady, 1884, "Challenger" Rep., p. 536, pl. lxvi. figs. 24, 25.

One broken specimen at 1020 fathoms.

Cristellaria variabilis, Reuss.

Cristellaria variabilis, Reuss, 1849, Denkschr. d. k. Akad. Wiss. Wien., vol. i. p. 369, pl. xlvi. figs. 15, 16.

Rare at 750 fathoms; common at 345 fathoms.

Cristellaria crepidula, Fichtel and Moll, sp.

Nautilus crepidula, Fichtel and Moll, 1803, Test. Micr., p. 107, pl. 19, figs. g.–i.

Found in all the gatherings; frequent at 7 fathoms.

Cristellaria italica, Defrance, sp.

Saracenaria italica, Defrance, 1824, Dict. Sci. Nat., vol. xxxii. p. 177; vol. xlvii. p. 344; Atlas Conch., pl. xiii. fig. 6.

A single specimen at 345 fathoms.

Cristellaria rotulata, Lamarck, sp.

Lenticulites rotulata, Lamarck, 1804, Annales du Muséum, vol. v. p. 188, No. 3; Tableau Encycl. et Méth., pl. ccccl xvi. fig. 5.

Very rare at 53–750 fathoms.

Cristellaria cultrata, Montfort, sp.

Robulus cultratus, Montfort, 1808, Conchyl. Systém, vol. i. p. 214, 54° genre.

Rare at 345–1020 fathoms.

AMPHICORYNE, Schlumberger.

Amphicoryne falx, Jones & Parker, sp.

Marginulina falx, Jones and Parker, 1860, Quart. Jour. Micr. Soc., vol. xvi. p. 302, No. 28.

Rare at 345 fathoms.

Sub-family, POLYMORPHININÆ.

POLYMORPHINA, d'Orbigny.

Polymorphina lactea, Walker and Jacob, sp.

Serpula lactea, Walker and Jacob, 1798 (fide Kanmacher), Adam's Essays, 2nd ed., p. 634, pl. xxiv. fig. 4.

7–750 fathoms; common at 7 fathoms.

Polymorphina lactea, *var.* oblonga, Williamson.

Polymorphina lactea, *var.* oblonga, Williamson, 1858, Rec. For. Gr. Br., p. 71, pl. vi. figs. 149, 149a.

Rare at 53 fathoms; frequent at 7 fathoms.

Polymorphina gibba, d'Orbigny.

Polymorphina (Globulina) gibba, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 266, No. 20; Modèle, No. 63.

Rare at 53 fathoms; frequent at 7 fathoms.

Polymorphina lanceolata, Reuss.

Polymorphina lanceolata, Reuss, 1851, Zeitschr. d. deutsch. Geol. Gesellsch., vol. iii. p. 83, pl. vi. fig. 50.

One specimen at 345 fathoms.

Polymorphina compressa, d'Orbigny.

Polymorphina compressa, d'Orbigny, 1846, For. Foss. Vien., p. 233, pl. xii. figs. 32–34.

Rare at 53 fathoms.

Polymorphina rotundata, Bornemann, sp.

Guttulina rotundata, Bornemann, 1855, Zeitschr. d. deutsch. Geol. Gesell., vol. vii. p. 346, pl. xviii. fig. 3.

Rare at 53 fathoms and 750 fathoms. A fistulose specimen was found at 53 fathoms.

Polymorphina concava, Williamson.

Polymorphina lactea, *var.* concava, Williamson, 1858, Rec. For. Gr. Br., p. 72, pl. vi. figs. 151, 152.

A single specimen at 345 fathoms.

Polymorphina myristiformis, Williamson.

Polymorphina myristiformis, Williamson, 1858, Rec. For. Gr. Br., p. 73, pl. vi. figs. 156, 157.

Rare at 7 fathoms and 53 fathoms.

UVIGERINA, d'Orbigny.

Uvigerina pygmæa, d'Orbigny.

Uvigerina pygmæa, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 269, pl. xii. figs. 8, 9; Modèle, No. 67.

Found in all the gatherings; common at 53 fathoms.

Uvigerina angulosa, Williamson.

Uvigerina angulosa, Williamson, 1858, Rec. For. Gr. Br., p. 67, pl. v. fig. 140.

Found in all the gatherings, and common in several of them.

Uvigerina aculeata, d'Orbigny.

Uvigerina aculeata, d'Orbigny, 1846, For. Foss. Vien., p. 191, pl. xi. figs. 27, 28.

Common at 1020 fathoms; many of the specimens intermediate between *U. aculeata* and *U. pygmæa*.

Uvigerina asperula, Czjzek.

Uvigerina asperula, Czjzek, 1847, Haidinger's Naturw. Abhandl., vol. ii. p. 146, pl. xiii. figs. 14, 15.

Rare at 750 fathoms; common at 345 fathoms.

Family, GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny.

Globigerina bulloides, d'Orbigny.

Globigerina bulloidos, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 277, No. 1; Modèles, Nos. 17 and 76.

In all the gatherings, and abundant in most of them.

Globigerina inflata, d'Orbigny.

Globigerina inflata, d'Orbigny, 1839, Foram. Canaries, p. 134, pl. ii. figs. 7–9.

Very common at 345–1020 fathoms; rare at 53 fathoms.

Globigerina rubra, d'Orbigny.

Globigerina rubra, d'Orbigny, 1839, Foram. Cuba, p. 94, pl. iv. figs. 12–14.

Frequent at 750 fathoms; rare at 345 fathoms and 1020 fathoms.

Globigerina æquilateralis, Brady.

Globigerina æquilateralis, Brady, 1879, Quart. Jour. Micr. Sci., vol. xix. (N. S.), p. 285.

7–1020 fathoms; rare near land; frequent in the deep-water gatherings.

Globigerina sacculifera, Brady.

Globigerina sacculifera, Brady, 1877, Geol. Mag., Dec. 11, vol. iv. p. 535.

Rare at 345 fathoms.

ORBULINA, d'Orbigny.

Orbulina universa, d'Orbigny.

Orbulina universa, d'Orbigny, 1839, Foram. Cuba, p. 3, pl. i. fig. 1.

Rare near land, but common in deep water.

HASTIGERINA, Wyville Thomson.

Hastigerina pelagica, d'Orbigny, sp.

Nonionina pelagica, d'Orbigny, 1839, Foram. Amér. Mérid., p. 27, pl. iii. figs. 13, 14.

A single specimen at 750 fathoms.

PULLENIA, Parker and Jones.

Pullenia sphæroides, d'Orbigny, sp.

Nonionina sphæroides, d'Orbigny, 1826, Ann. Sci. Nat. vol. vii. p. 293, No. 1; Modèle, No. 43.

Very rare at 345 fathoms and 750 fathoms.

Pullenia quinqueloba, Reuss.

Nonionina quinqueloba, Reuss, 1851, Zeitschr. d. deutsch. Geol. Gesell., vol. iii. p. 71, pl. v. fig. 31.

Frequent at 345 fathoms; rare at 750 fathoms and 1020 fathoms.

SPHÆROIDINA, d'Orbigny.

Sphæroidina bulloides, d'Orbigny.

Sphæroidina bulloides, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 267, No. 1; Modèle, No. 65.

53–750 fathoms; frequent at 345 fathoms.

Family, ROTALIDÆ. *Sub-family*, ROTALINÆ.

PATELLINA, Williamson.

Patellina corrugata, Williamson.

Patellina corrugata, Williamson, 1858, Rec. For. Gr. Br., p. 46, pl. iii. figs. 86–89.

Rare at 50–750 fathoms; frequent at 7 fathoms.

DISCORBINA, Parker and Jones.

Discorbina globularis, d'Orbigny, sp.

Rosalina globularis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 271, No. 1, pl. xiii. figs. 1–4; Modèle, No. 69.

7–345 fathoms; frequent near the coast.

Discorbina rosacea, d'Orbigny, sp.

Rotalia rosacea, d'Orbigny, 1826, Ann. Sci. Nat. vol. vii. p. 273, No. 15; Modèle, No. 39.

Very rare at 750 fathoms; common at 7 fathoms.

Discorbina nitida, Williamson, sp.

Rotalina nitida, Williamson, 1858, Rec. For. Gr. Br., p. 54, pl. iv. figs. 106–108.

In all the gatherings, except 345 fathoms.

Discorbina bertheloti, d'Orbigny, sp.

Rosalina bertheloti, d'Orbigny, 1839, Foram. Canaries, p. 135, pl. i. figs. 28–30.

7–750 fathoms; common at 345 fathoms.

PLANORBULINA, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, No. 2, pl. xiv. figs. 4–6; Modèle, No. 79.

Frequent at 7–53 fathoms.

TRUNCATULINA, d'Orbigny.

Truncatulina refulgens, Montfort, sp.

Cibicides refulgens, Montfort, 1808, Conchyl. Systém., vol. i. p. 122, 31ᵉ genre.

Rare at 50 fathoms and 53 fathoms.

Truncatulina lobatula, Walker and Jacob, sp.

Nautilus lobatulus, Walker and Jacob, 1798, Adam's Essays, Kanmacher's Ed., p. 642, pl. xiv. fig. 36.

7–345 fathoms; very common near the coast.

Truncatulina ungeriana, d'Orbigny, sp.

Rotalina ungeriana, d'Orbigny, 1846, For. Foss. Vien., p. 157, pl. viii. figs. 16–18.

Common at 750 fathoms and 1020 fathoms; rare at 50 fathoms and 345 fathoms.

Truncatulina wuellerstorfi, Schwager, sp.

Anomalina wüllerstorfi, Schwager, 1866, Novara-Exped., Geol. Theil., vol. ii. p. 258, pl. vii. figs. 105, 107.

Rare at 345 fathoms and 750 fathoms; common at 1020 fathoms.

ANOMALINA, d'Orbigny.

Anomalina ariminensis, d'Orbigny, sp.

Planulina ariminensis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 280, pl. v. figs. 1–3, bis; Modèle, No. 49.

Frequent at 345 fathoms; rare at 750 fathoms.

PULVINULINA, Parker and Jones.

Pulvinulina auricula, Fichtel and Moll., sp.

Nautilus auricula, *var.* a, Fichtel and Moll., 1803, Test. Micr., p. 108, pl. xx. figs. a, b, c; *var.* β, id. ibid., figs. d, e, f.

In all the gatherings, except 750 fathoms; very common at 53 fathoms.

Pulvinulina canariensis, d'Orbigny, sp.

Rotalina canariensis, d'Orbigny, 1839, Foram. Canaries, p. 130, pl. i. figs. 34–36.

Rare at 53 fathoms; common at 345–1020 fathoms.

Pulvinulina patagonica, d'Orbigny, sp.

Rotalina patagonica, d'Orbigny, 1839, Foram. Amér. Mérid., p. 36, pl. ii. figs. 6–8.

Very rare at 53 fathoms; common at 345–1020 fathoms.

Pulvinulina micheliniana, d'Orbigny, sp.

Rotalina micheliniana, d'Orbigny, 1840, Mém. Soc. Geol. France, vol. iv. p. 31, pl. iii. figs. 1–3.

Common at 345–1020 fathoms.

Pulvinulina karsteni, Reuss, sp.

Rotalia karsteni, Reuss, 1855, Zeitschr. d. deutsch. Geol. Gesell., vol. vii. p. 273, pl. ix. fig. 6.

345–1020 fathoms; common at 750 fathoms.

Pulvinulina elegans, d'Orbigny, sp.

Rotalia (Turbinulina) elegans, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 276, No. 54.

Very rare at 345–1020 fathoms.

ROTALIA, Lamarck.

Rotalia beccarii, Linné, sp.

Nautilus beccarii, Linné, 1767, Syst. Nat., 12th ed., p. 1162.

In all the gatherings; common near the coast.

Rotalia orbicularis, d'Orbigny.

Rotalia (Gyroidina) orbicularis, d'Orbigny, 1826, Ann. Sci. Nat., vol. vii. p. 278, No. 1; Modèle, No. 13.

Frequent at 345–1020 fathoms.

Sub-family, Tinoporinæ.

GYPSINA, Carter.

Gypsina inhærens, Schultze, sp.

Acervulina inhærens, Schultze, 1854, Organ. der Polythal., p. 68, pl. vi. fig. 12.

Rare at 7 fathoms.

Family, Nummulinidæ. *Sub-family*, Polystomellinæ.

NONIONINA, d'Orbigny.

Nonionina depressula, Walker and Jacob, sp.

Nautilus depressulus, Walker and Jacob, 1798, Adam's Essays, Kanmacher's Ed., p. 641, pl. xiv. fig. 33.

Very rare at 345 fathoms; very common at 7 fathoms.

Nonionina umbilicatula, Montagu, sp.

Nautilus umbilicatulus, Montagu, 1803, Test. Brit., p. 191; suppl., p. 78, pl. xviii. fig. 1.

In all the gatherings; common at 53 fathoms and 750 fathoms.

Nonionina pompilioides, Fichtel and Moll., sp.

Nautilus pompilioides, Fichtel and Moll., 1803, Test. Micr., p. 31, pl. ii. figs. a–e.

One specimen at 1020 fathoms.

Nonionina pauperata, Balkwill and Wright.

Nonionina pauperata, Balkwill and Wright, 1885, Trans. R. Irish Acad., vol. xxviii. (Science) p. 353, pl. xiii. figs. 25, 26.

Very rare at 53 fathoms and 345 fathoms.

Nonionina turgida, Williamson, sp.

Rotalina turgida, Williamson, 1858, Rec. For. Gr. Br., p. 50, pl. iv. figs. 95–97.

In all the gatherings; common in most of them.

Nonionina scapha, Fichtel and Moll, sp.

Nautilus scapha, Fichtel and Moll, 1803, Test. Micr., p. 105, pl. xix. figs. d–f.

Very rare at 345 fathoms and 750 fathoms.

Nonionina stelligera, d'Orbigny.

Nonionina stelligera, d'Orbigny, 1839, Foram. Canaries, p. 128, pl. iii. figs. 1, 2.

Rare at 53–750 fathoms.

POLYSTOMELLA, Lamarck.

Polystomella crispa, Linné, sp.

Nautilus crispus, Linné, 1767, Syst. Nat. 12th Ed., p. 1162, 275.

Very rare at 1020 fathoms; very common at 7 fathoms.

Polystomella striatopunctata, Fichtel and Moll, sp.

Nautilus striatopunctatus, Fichtel and Moll. 1803, Test. Micr. p. 61, pl. ix. figs. a–c.

7–750 fathoms; very common at 7 fathoms.

Sub-family, NUMMULITINÆ.

OPERCULINA, d'Orbigny.

Operculina ammonoides, Gronovius, sp.

Nautilus ammonoides, Gronovius, 1781, Zooph. Gron., p. 282, No. 1220.

In all the gatherings; common at 53 fathoms.

TABLE OF THE DISTRIBUTION OF RECENT FORAMINIFERA OFF THE SOUTH-WEST COAST OF IRELAND.

ABBREVIATIONS:—vr, very rare; r, rare; c, common; vc, very common; f, frequent.

	SPECIES.	Log 4: lat. 50° 52′ N., long. 11°27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11°27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9: from stomach of Holothuria; 50 fms.; mud.	Log 6: Berehaven Harbour; 7 fms.; mud.
		1.	2.	3.	4.	5.	6.
1	Biloculina irregularis, d'Orb., . .	..	vr	vr	..	..	..
2	—— sphæra, d'Orb., ...	..	r	vr	vr	..	..
3	—— bulloides, d'Orb., . . .	vr	r	vr	..	..	..
4	—— ringens, Lamk., ...	..	vr	r	f	..	f
5	—— —— *var.* elongata, d'Orb., .	..	..	vr	..	..	..
6	—— depressa, d'Orb., ...	..	..	vr	f	r	f
7	—— —— *var.* murrhyna, Schw., .	r	f	..	..	..	..
8	Spiroloculina planulata, Lamk., .	..	..	..	vr	..	f
9	—— limbata, d'Orb., ...	..	..	..	c	..	..
10	—— tenuisepta, Br., ...	..	r	f	c	..	r
11	—— acutimargo, Br., ...	..	..	..	vr	..	vr
12	—— canaliculata, d'Orb., . .	..	..	..	f	..	f
13	Miliolina trigonula, Lamk. . .	..	r	r	c	..	f
14	—— tricarinata, d'Orb., ...	vr	vr	r	vr	..	f
15	—— oblonga, Montag., . . .	..	vr	vr	r	..	r
16	—— seminulum, Linn., ...	..	..	..	r	..	c
17	Miliolina auberiana, d'Orb., . .	r	f	f	c	f	..
18	—— contorta, d'Orb., . . .	..	..	..	r	..	c
19	—— labiosa, d'Orb., ...	..	..	..	f	..	f
20	—— subrotunda, Montag., . .	..	..	vr	vr	vr	c

	Species.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11° 27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9; from stomach of Holothuria; 50 fms.; mud.	Log 6; Berehaven Harbour; 7 fms.; mud.
		1.	2.	3.	4.	5.	6.
21	Miliolina ferussacii, d'Orb.,	..	..	..	r	..	vr
22	—— bicornis, W. & J.,	..	..	..	r	..	r
23	—— agglutinans, d'Orb.,	..	..	vr	..	..	..
24	Segmöilina celata, Costa,	c	c	r	r	f	..
25	—— tenuis, Czjz.,	f	f	f	f	vr	r
26	Planispirina contraria, d'Orb.,	..	..	..	c	..	..
27	Ophthalmidium inconstans, Br.,	..	vr	..	..	..	..
28	—— carinatum, Balkwill & Wright,	..	vr	..	..	..	vr
29	Cornuspira foliacea, Phil.,	..	..	..	..	..	vr
30	—— involvens, Rss.,	..	vr	..	..	..	r
31	—— carinata, Costa.,	..	..	vr	r	..	..
32	Astrorhiza arenaria, Norm.,	..	..	c	..	..	..
33	Psammosphæra fusca, Schulze,	..	r	..	..	..	..
34	Hyperammina elongata, Br.,	r	r	r	..	..	..
35	—— —— *var.* lævigata, Nov.,	..	..	r	..	..	..
36	Marsipella elongata, Norm.,	..	vr	..	..	..	..
37	Rhabdammina abyssorum, M. Sars,	..	f	..	..	..	..
38	Reophax difflugiformis, Br.,	..	vr	vr	..	..	..
39	—— fusiformis, Will.,	..	..	..	c	f	c
40	—— scorpiurus, Montf.,	r	vr	r	r	r	vr
41	—— guttifera, Br.,	..	f	r	..	..	..
42	Haplophragmium pseudospirale, Will.,	..	..	vr	f	c	r
43	—— canariense, d'Orb.,	..	r	r	c	vr	f
44	—— globigeriniforme, P. & J.,	..	..	r	c	r	vr
45	—— glomeratum, Br.,	..	c	vr	c	vr	vr
46	Placopsilina cenomana, d'Orb.,	..	..	vr	..	..	..
47	Thurammina papillata, Br.,	vr	vr	vr	..	..	..
48	Hormosina globulifera, Br.,	..	vr	..	..	..	..

	Species.	Log 4: lat. 50° 52' N., long. 11°27' W.; 1020 fms.; ooze.	Log 5: lat. 51° 1' N., long. 11°50' W.; 750 fms.; mud.	Log 3: lat. 51° 2' N., long. 11°27' W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9: from stomach of Holothuria; 50 fms.; mud.	Log o. Berehaven Harbour; 7 fms.; mud.
		1.	**2.**	**3.**	**4.**	**5.**	**6.**
49	Ammodiscus incertus, d'Orb.,	..	..	..	r	..	..
50	—— gordialis, J. & P.,	..	..	vr	r	vr	..
51	—— charoides, J. & P.,	..	..	vr	vr	..	..
52	Trochammina squamata, J. & P.,	..	..	..	vr	..	f
53	—— plicata, Terq.,	..	..	..	..	..	r
54	—— inflata, Montag., *var.*,	r	..	vr	..	..	..
55	—— nitida, Br.,	..	r	r	r	..	..
56	—— robertsoni, Br.,	c	vr	r	vc	r	vr
57	Webbina clavata, J. & P.,	..	c	..	..	..	..
58	Cyclammina cancellata, Br.,	..	..	r	..	..	..
59	Textularia concava, Kar.,	..	..	r	r	..	r
60	—— agglutinans, d'Orb.,	..	..	vr	vr	vr	..
61	—— gramen, d'Orb.,	..	..	f	c	r	c
62	—— globulosa, Ehr.,	..	..	vr	..	..	..
63	Spiroplecta sagittula, Defr.,	..	..	r	c	f	r
64	Bigenerina digitata, d'Orb.,	..	..	..	vc	r	r
65	—— nodosaria, d'Orb.,	..	vr	..	r	..	..
66	Gaudryina pupoides, d'Orb.,	..	c	c	..	..	..
67	—— filiformis, Berth.,	f	..	r	r	r	f
68	Verneuilina polystropha, Rss.,	..	..	..	f	r	f
69	—— spinulosa, Rss.,	..	vr	..	..	..	..
70	—— pygmæa, Egger,	r	r	..	..	..	..
71	Valvulina conica, P. & J.,	..	r	..	..	..	..
72	—— fusca, Will.,	..	r	f	r	r	..
73	Bulimina elegans, d'Orb.,	..	..	r	..	..	..
74	—— pyrula, d'Orb.,	..	..	f	..	..	..
75	—— ovata, d'Orb.,	f	r	f	c	..	f
76	—— affinis, d'Orb.,	..	r	..	..	..	..

	Species.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11° 27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9: from stomach of Holothuria; 50 fms.; mud.	Log 6: Berehaven Harbour; 7 fms.; mud.
		1.	**2.**	**3.**	**4.**	**5.**	**6.**
77	Bulimina pupoides, d'Orb.,	r	r	r	f	vr	vc
78	—— fusiformis, Will.,	r	f	f	f	f	vc
79	—— elegantissima, d'Orb.,	vr	..	..	..	..	f
80	—— subteres, Br.,	..	r	r	vr	..	r
81	—— marginata, d'Orb.,	r	f	c	c	f	f
82	—— inflata, Seg.,	c	f	vr	..	..	..
83	—— buchiana, d'Orb.,	..	r	r	r	..	..
84	Virgulina schreibersiana, Czjz.,	c	r	r	r	..	c
85	Bolivina punctata, d'Orb.,	f	f	f	r	vr	f
86	—— lævigata, Will.,	c	c	c	r	vr	f
87	—— plicata, d'Orb.,	..	r	r	r	..	f
88	—— difformis, Will.,	r	f	f	c	r	vc
89	—— dilatata, Rss.,	..	c	c	f	r	c
90	—— ænariensis, Costa,	f	c	f	..	..	..
91	—— decussata, Br.,	c	..	..	..	..	..
92	—— quadrilatera, Schw.,	r	f	..	vr	..	..
93	Cassidulina lævigata, d'Orb.,	f	c	c	c	f	c
94	—— crassa, d'Orb.,	r	f	c	f	r	f
95	—— bradyi, Norm.,	..	r	r	f	..	r
96	Chilostomella ovoidea, Rss.,	..	..	f	f	..	..
97	Seabrookia earlandi, Wright,	..	..	f	..	..	..
98	Lagena globosa, Montag.,	vr	vr	vr	vr	vr	vr
99	—— apiculata, Rss.,	f	r	vr	vr	..	..
100	—— botelliformis, Br.,	..	vr	..	..	..	..
101	—— lævis, Montag.,	r	..	..	r	..	f
102	—— —— *var.* clavata, d'Orb.,	..	vr	r	f	r	c
103	—— —— *var.* gracillima, Seg.,	..	vr	vr	..	..	..
104	—— aspera, Rss.,	..	..	..	..	..	vr

	Species.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11° 27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9: from stomach of Holothuria; 50 fms.; mud.	Log 6: Berehaven Harbour; 7 fms.; mud.
		1.	**2.**	**3.**	**4.**	**5.**	**6.**
105	Lagena hispida, Rss.,	r	vr	r	f	..	vr
106	—— lineata, Will.,	..	vr	vr	f	..	f
107	—— striata, d'Orb.,	r	r	r	c	r	c
108	—— distoma, P. & J.,	vr	vr	vr	..	..	..
109	—— gracilis, Will.,	r	f	r	vr	vr	r
110	—— sulcata, W. & J.,	..	f	f	c	r	c
111	—— williamsoni, Alcock,	..	vr	r	f	..	f
112	—— costata, Will.,	..	..	..	r	..	..
113	—— semistriata, Will.,	..	r	r	f	..	c
114	—— crenata, P. & J.,	..	..	vr	..	..	..
115	—— striatopunctata, P. & J.,	..	..	..	..	..	vr
116	—— squamosa, Montag.,	vr	..	..	f	..	c
117	—— hexagona, Will.,	r	f	r	f	..	r
118	—— hertwigiana, Br.,	..	vr	..	..	..	..
119	—— lævigata, Rss.,	r	r	f	c	r	f
120	—— —— *var.* lucida, Will.,	..	..	..	f	..	c
121	—— —— *var.* quadrata, Will.,	..	..	vr	vr	..	f
122	—— —— *var.* aperta, Seg.,	..	..	..	f	..	c
123	—— fimbriata, Br.,	..	vr	f	f	..	r
124	—— staphyllearia, Schw.	r	vr	..	..	..	..
125	—— marginata, W. & B.,	vr	c	f	f	..	c
126	—— —— trigonal form,	..	..	r	..	..	..
127	—— —— *var.* inæquilateralis, Wright,	..	..	..	..	..	r
128	—— lagenoides, Will.,	..	..	r	f	..	c
129	—— —— *var.* tenuistriata, Br.,	..	..	..	vr	..	vr
130	—— orbignyana, Seg.,	..	f	f	c	f	c
131	—— —— *var.* walleriana, Wright,	..	..	f	vr	..	..
132	—— —— *var.* variabilis, Nov.	..	f	..	..	..	..

	Species.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11° 27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9; from stomach of Holothuria; 50 fms.; mud.	Log 6: Berehaven Harbour; 7 fms.; mud.
		1.	2.	3.	4.	5.	6.
133	Lagena bicarinata, Terq.,	..	..	vr	f	..	f
134	Nodosaria (G.) lævigata, d'Orb.,	..	vr	f	vr	..	..
135	—— (G.) rotundata, Rss.,	..	vr	f	..	..	..
136	—— calomorpha, Rss.,	vr	r	..	..	..	..
137	—— pyrula, d'Orb,	..	..	r	f	vr	r
138	—— farcimen, Sold.,	..	r	..	..	..	..
139	—— consobrina, d'Orb.,	vr	vr	vr	vr	..	vr
140	—— —— *var.* emaciata, Rss.,	..	..	r	..	..	..
141	—— soluta, Rss.,	..	vr	..	..	..	..
142	—— communis, d'Orb.,	..	..	f	f	vr	r
143	—— mucronata, Neug.,	r	..	vr	..	..	vr
144	—— hispida, d'Orb.,	..	..	vr	..	..	..
145	—— scalaris, Batsch,	vr	r	f	f	r	r
146	—— —— *var.* separans, Br.,	..	..	vr	..	..	vr
147	—— raphanus, Linn.,	..	..	r	..	..	..
148	—— obliqua, Linn.,	..	..	vr	f	vr	..
149	Lingulina carinata, d'Orb.,	..	..	..	..	vr	vr
150	Vaginulina legumen, Linn.,	..	vr	vr	..	vr	..
151	—— linearis, Montag.,	..	..	..	..	vr	..
152	Rhabdogonium tricarinatum, d'Orb.,	..	..	c	..	..	..
153	Marginulina glabra, d'Orb.,	..	..	..	f	..	..
154	—— costata, Batsch,	..	..	vr	..	..	..
155	—— globosa,	..	..	vr	..	..	..
156	Cristellaria tenuis, Bornem.,	..	..	f	..	..	..
157	—— obtusata, *var.* subalata, Br.	vr	..	..	..	..	..
158	—— variabilis, Rss.,	..	r	c	..	..	..
159	—— crepidula, F. & M.,	vr	vr	r	vr	vr	f
160	—— italica, Defr.,	..	..	vr	..	..	..

	Species.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11° 27′ W.; 345 fms.; fine sand.	Log 8: 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9; from stomach of Holothuria; 50 fms.; mud.	Log 6: Berehaven Harbour; 7 fms.; mud.
		1.	2.	3.	4.	5.	6.
161	Cristellaria rotulata, Lamk.,	..	vr	vr	r	vr	..
162	—— cultrata, Montf.,	r	r	vr	..	..	..
163	Amphicoryne falx, J. & P.,	..	..	r	..	..	..
164	Polymorphina lactea, W. & J.,	..	vr	vr	f	..	c
165	—— —— *var.* oblonga, Will.,	..	..	..	r	..	f
166	—— gibba, d'Orb.,	..	..	..	r	..	f
167	—— lanceolata, Rss.,	..	..	vr	..	..	..
168	—— compressa, d'Orb.,	..	..	..	r	..	..
169	—— rotundata, Bornm.,	..	vr	..	r	..	..
170	—— —— fistulose form,	..	..	..	vr	..	..
171	—— concava, Will.,	..	..	vr	..	..	..
172	—— myristiformis, Will.,	..	..	..	r	..	r
173	Uvigerina pygmæa, d'Orb.,	vr	f	f	c	f	vr
174	—— angulosa, Will.,	c	c	c	c	r	f
175	—— aculeata, d'Orb.,	c	..	..	..	..	..
176	—— asperula, Czjz.,	..	r	..	..	..	..
177	Globigerina bulloides, d'Orb.,	c	vc	vc	c	r	f
178	—— inflata, d'Orb.,	vc	vc	vc	r	..	..
179	—— rubra, d'Orb.,	r	f	r	..	..	..
180	—— æquilateralis, Br.,	c	f	f	r	..	vr
181	—— sacculifera, Br.,	..	..	r	..	..	..
182	Orbulina universa, d'Orb.,	c	c	c	f	..	r
183	Hastigerina pelagica, d'Orb.,	..	vr	..	..	..	..
184	Pullenia sphæroides, d'Orb.,	..	vr	vr	..	..	..
185	—— quinqueloba, Rss.,	r	r	f	..	..	..
186	Sphæroidina bulloides, d'Orb.,	..	vr	f	r	..	..
187	Patellina corrugata, Will.,	..	vr	vr	vr	vr	f
188	Discorbina globularis, d'Orb.,	..	..	vr	f	r	f

	SPECIES.	Log 4: lat. 50° 52′ N., long. 11° 27′ W.; 1020 fms.; ooze.	Log 5: lat. 51° 1′ N., long. 11° 50′ W.; 750 fms.; mud.	Log 3: lat. 51° 2′ N., long. 11°27′W.; 345 fms.; fine sand.	Log 8; 11 miles S. of Glandore Hbr.; 53 fms.; muddy sand.	Log 9; from stomach of Holothuria; 50 fms.; mud.	Log 6; Berehaven Harbour; 7 fms.; mud.
		1.	2.	3.	4.	5.	6.
189	Discorbina rosacea, d'Orb.,	..	vr	..	..	..	c
190	—— nitida, Will.,	f	f	..	f	r	f
191	—— bertheloti, d'Orb.,	..	r	c	f	vr	r
192	Planorbulina mediterranensis, d'Orb.,	..	..	..	f	vr	c
193	Truncatulina refulgens, Montf.,	..	..	..	r	r	..
194	—— lobatula, W. & J.,	..	..	r	c	f	vc
195	—— ungeriana, d'Orb.,	c	c	vr	..	r	..
196	—— wuellerstorfi, Schw.,	c	r	r	..	..	..
197	Anomalina ariminensis, d'Orb.,	..	r	f	..	..	..
198	Pulvinulina auricula, F. & M.,	r	..	r	vc	vr	f
199	—— canariensis, d'Orb.,	c	vc	vc	r	..	..
200	—— patagonica, d'Orb.,	c	vc	c	vr	..	..
201	—— micheliniana, d'Orb.,	c	c	vc	..	..	..
202	—— karsteni, Rss.,	r	c	vr	..	..	..
203	—— elegans, d'Orb.,	vr	vr	vr	..	..	..
204	Rotalia beccarii, Linn.,	r	vr	r	c	r	c
205	—— orbicularis, d'Orb.,	c	f	f	..	..	..
206	Gypsina inhærens, Schultze,	..	..	..	..	..	r
207	Nonionina depressula, W. & J.,	..	..	vr	..	..	vc
208	—— umbilicatula, Montag.,	r	c	f	c	f	r
209	—— pompilioides, F. & M.,	vr	..	..	..	..	..
210	—— pauperata, Balkwill & Wright,	..	..	vr	vr	..	..
211	—— turgida, Will.,	f	c	c	c	f	f
212	—— scapha, F. & M.,	..	vr	vr	..	..	..
213	—— stelligera, d'Orb.,	..	r	r	vr	..	..
214	Polystomella crispa, Linn.,	vr	..	..	..	..	c
215	—— striatopunctata, F. & M.,	..	r	f	r	r	c
216	Operculina ammonoides, Gron.,	r	vr	r	c	f	f

DESCRIPTION OF PLATE XX.

Figure.

1. Hyperammina elongata, *var.* lævigata, nov., × 50 diam.

   Log 3, 345 fathoms.

2. Webbina clavata, J. & P., adherent specimen, × 20 diam.

   Log 5, 750 fathoms.

3. Webbina clavata, J. & P., with long tubular neck adherent to bits of rounded quartz, × 20 diam.

   Log 5, 750 fathoms.

4. Trochammina robertsoni, Br. 4 a, lateral aspect; 4 b, peripheral aspect, × 100 diam.

   Log 8, 53 fathoms.

5. [Seabrookia pellucida, Brady. 5 a, lateral aspect by transmitted light; 5 b, oral aspect, × 100 diam. Java Sea, 45 fathoms.]

6. Seabrookia earlandi, J. Wright, lateral aspect by transmitted light, × 100 diam.

   Log 3, 345 fathoms.

7. Seabrookia earlandi, J. Wright. 7 a, superior lateral aspect; 7 b, oral aspect, × 100 diam.

   Log 3, 345 fathoms.

8. Lagena orbignyana, *var.* wallerina, J. Wright. 8 b, oral aspect, × 100 diam.

   Log 3′, 345 fathoms.

9. Lagena orbignyana, *var.* variabilis, J. Wright. 9 b, oral aspect, × 100 diam.

   Log 5, 750 fathoms.

XLIV.

ON THE OCCURRENCE OF SERPENTINE AT BRAY HEAD.

By Professor J. P. O'REILLY, Royal College of Science, Dublin. (Plate XXI.)

[Read June 23, 1890.]

In the Paper submitted to the Academy, January 28, 1889, "On the directions of the lines of Jointing observable in the neighbourhood of the Bay of Dublin," the conclusion was arrived at, "that taking all the characteristics and conditions of the Rocks of Bray Head into consideration, there are strong reasons for questioning the purely sedimentary origin and nature which up to the present has been assigned to them (the Bray Head Rocks) by geologists." I further added:—"The reasons which have tended to force this view upon me may be classed under the two heads, Physical Characteristics and Chemical Composition"; and I proposed to treat the question fully when making my Report on the results of the chemical analyses of the Bray Head Rocks for which grants of money had been given to me by the Academy.

The continued examination of these Rocks, on the one hand, as well as the difficulty and delay attending the execution of a sufficient number of analyses to meet the requirements of the problem involved, have prevented the Report being brought to that state of completeness which I had hoped it to attain, and in which I am desirous of submitting it to the Academy. As a matter of fact, new observations are being continually made, and completeness of results seems hardly yet attainable. As, however, the subject of the present Paper may be treated separately, as it forms an excellent introduction to what I may have to say regarding the Bray Head Rocks taken as a whole, and as finally it brings out well the importance of chemical analyses for the determination of the true nature of this very remarkable series of beds, I have thought it advisable to submit the present Paper without further delay.

The bed to which the following details refer has a history which it is desirable to record here. In the memoir to sheets 121 and 130 of the Geological Survey of Ireland, illustrating a portion of the counties

of Wicklow and Dublin, by J. Beete Jukes, M.A., F.R.S., and G. V. Du Noyer, M.R.I.A., published in 1869 (subsequent to the deaths of these gentlemen), and in the section describing the Bray Head district, at p. 25, occurs the paragraph :—"The southern end of the coast section affords the usual greenish and reddish purple grits and hard slate layers; and at a distance of about half a mile N. of the Cable Rock (or Half-tide rock) these are traversed somewhat in their line of strike, *i.e.* from N.E. to S.W., by a greenstone dyke which on the shore branches into numerous veins. The N.E. end of the dyke is dislocated for the distance of about 60 yards by a fault nearly E. and W., the down throw being to the south. The dyke can be traced up the hill for the distance of about 260 yards." The following foot-note is added:—"This dyke was first discovered by Professor Harkness, and has been minutely described by Mr. W. H. S. Westropp in the Journal of the Geological Society of Ireland for the year 1866."

Turning to this description, which appears in vol. I., part ii., for the year 1865–66, p. 149, with the title, "On a Trap Rock at Bray Head, Co. Wicklow, by W. H. Stackpoole Westropp, M.R.I.A.," the following details are therein found:—

P. 150.—"Some time ago Professors Harkness and King discovered a bed of greenstone about 100 yards south of the Windgate quartz rock, by the side of an old road, running a little above the present walk, which skirts the eastern side of the hill; these gentlemen told Mr. Jukes of its occurrence there, and during Easter week last year (1864) Mr. Jukes showed it to me when he was giving a field lecture to his Geological Class; he said he had traced it up the hill, but that no one had tried to find its extension down to the seashore."

The author then gives the following results of his examination:—"From the place where the trap can be first seen towards the top of the hill, down to the spot where Professors Harkness and King noticed it by the old roadside, it appears to occur in one bed about 5 feet thick, regularly interstratified with the grits and slates. In the cliff between the walk and the railway it begins to show a tendency to split up, for a second bed only an inch or two thick appears, which runs parallel to the mainbed, and is separated from it by grits, &c. The trap disappears under the railway embankment, and would not again be seen but for a fault having an upthrow to N.N.W. of about 150 feet; this brings up the trap about 60 yards to the N., where it may be seen on both sides of the railway near the south entrance of the tunnel. Below the railway it becomes split up into several beds; and on the eashore I counted as many as seven, varying in thickness from

2 inches to 1 foot; there are also some curious fine veins of 0·25 to 0·5 inch thick.

"The rock is greenstone, having different textures in different parts; up the hill, where it occurs in one bed, it is a hard finely crystalline rock, of a dark grayish colour and very durable, for it is scarcely at all affected by weathering; but where it becomes split up into a number of beds, it is a rotten brownish green rock, with numerous black specks of a mineral, which probably is hornblende; some of these beds have quite the look of ash.

"The trap is so regularly interstratified with the sedimentary rocks that at first sight it might be supposed to be contemporaneous; however I believe it to be intrusive, for the fine veins, before alluded to, may be seen entering the adjacent beds of slate, some dying away, while others cut across the laminæ of the slate in a manner that I cannot think that an ash would behave; nevertheless, anyone examining a hand specimen of one of these veins would be inclined to call it an ash. In conclusion, I beg to observe that, while there is such a profusion of igneous rocks associated with the lower Silurian deposits of Wicklow, it is rather remarkable that one small greenstone dyke at Greystones, and the trap I have just described, are the only ones which have yet been found in the Cambrian rocks of that county."

In the discussion on this Paper (given on p. 179 of the same Journal) Professor Jukes is reported to have said :—"He could understand his (Mr. Westropp's) having been perplexed at the ashy appearance of some of the branching veins which he had described, because he himself had been occasionally perplexed as to whether particular masses of trap were ash, or were crystalline rock decomposed. But the fact that the geeenstone which he described, as running persistently between two beds in the upper part of the mountain, split into two or three beds below (a circumstance of which he had not been previously aware), proved that the greenstone was intrusive. The small veins issuing from it were an additional proof to the same effect. Such intrusions were not uncommon. He knew of beds of intrusive greenstone running evenly between other beds for miles of length and breadth, preserving almost the same thickness throughout, and not producing any appreciable alteration in the beds above or below. When he first surveyed N. Wales in conjunction with Mr. Selwyn, Mr. Selwyn was obliged, after he had mapped out the country, to spend some months in going over the whole ground again, and hammering every suspicious-looking rock; for it was only in that way that crystalline greenstone could be known from green siliceous grits.

Anyone examining the maps of that country would see minute red lines, indicating the occurrence of narrow veins of greenstone. In the neighbouring district were lower Silurian beds, in which there were trap rocks of all kinds, in great quantities, and of great thickness. It was clear that the trap in the lower Silurian must have come up through Cambrian; and therefore it was at first sight odd that there should be so little trap in the Cambrian, where that only was exposed to view, and such an immense development of it in the Silurian. But this might be accounted for by the supposition that the trap had passed through channels or pipes of communication. Therefore it was quite possible that, in the county of Wicklow, the trap might have passed through such channels as were described by Mr. Westropp. No matter how much a district was worked, it was impossible to exhaust the facts of it. Bray Head was twice examined by most careful workmen, who yet never saw this bed of greenstone. Mr. Harkness did discover it near the old road, and reported the fact to him (Mr. Jukes), but he did not credit it at first."

I have given the whole of these details because of their importance in estimating what has been done for the exact determination of the Bray Head Rocks.

In the first place, it may be observed that Messrs. Harkness, King, Jukes, and Westropp all speak of the dyke as a greenstone, without further determination apparently than that afforded by mere inspection.

Secondly—while the survey memoir states that the dyke traverses "the usual greenish and reddish purple grits and hard slate layers" somewhat in their line of strike, *i.e.* from N.E. to S.W., Mr. Westropp's careful description (accepted by Mr. Jukes) shows that the dyke from the top of the hill to the old road above the path is regularly interstratified with the beds.

Thirdly—that it branches into these beds between which come in grit beds.

Fourthly—that the so-called greenstone presents different textures in different parts: in one place, a hard finely crystalline texture, of a dark grayish colour, and then very durable; in another, where split up, it is a rotten brownish green rock, with numerous black specks of a mineral which probably is hornblende.

Fifthly—some of these thin beds have quite the look of an ash.

Bringing out the significance of these details, we have Mr. Jukes stating that he, too, had sometimes been perplexed as to whether particular masses of trap were ash or were crystalline rock decomposed;

part. The colour is only faintly green; on the fresh fracture rather and admitting that, from the fact of the rock being split up as described, it must be intrusive.

We have, also, his important remarks as to the survey of N. Wales by Mr. Selwyn, and his "hammering of every suspicious-looking rock, for it was only in that way that crystalline greenstone could be known from green silicious grit;" his endeavours to explain the seeming anomaly of an abundance of eruptive rocks in the lower Silurian, and their absence in the Cambrian through which they must have passed.

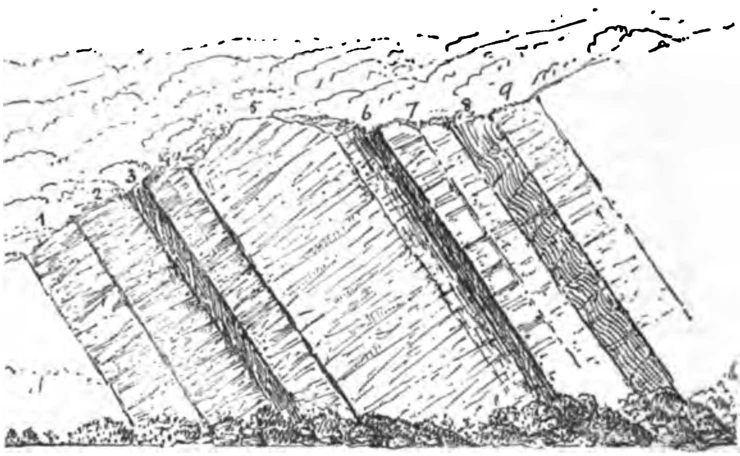
Finally, his very significant statements, "that no matter how much a district was worked, it was impossible to exhaust the facts of it"—"that Bray Head was twice examined by most careful workmen, who yet never saw this bed of greenstone"—and lastly, his admitted incredulity as to its existence when it was first reported to him.

All this points to the clear conclusion that nearly everything has yet to be done for the accurate determination of the true nature of these rocks and of their stratigraphical relations.

I submit the results of my own observations as a contribution towards these ends. I accept Mr. Westropp's description of the dyke, as it appears on the old road and on the railway cutting, as practically correct and give sketches of the dyke as it appears in these two places, *see* page 508 and Plate XXI. As to the splitting up into branches on the shore, I have been unable to verify this, as the rocks are difficultly accessible, so far as I am aware only by boat; but there is visible from the path a series of dark-grey beds projecting into the sea, which may be the continuation of this dyke, but may possibly be a different set separated from the dyke observed by one of the many faults which influence so markedly the outline of the coast here (as a matter of fact the beds here are both markedly faulted and much disturbed). As to the true nature of the rock I had samples, taken from the outcrop on the railway, analysed; and the results, taken in connexion with the hardness, density, and the appearance of the rock in thin section under the microscope, prove it to be a serpentine, but evidently a product of alteration of a basic rock, as most serpentines are. The density determined on two specimens was found to be 2·803. This agrees well with that mentioned in Dana's "Mineralogy" (5th ed., 1874), p. 804, for a dark-green serpentine of Newbury, Mass., U. S., given as 2·804. The hardness is about 3·5, the rock being easily cut by fluor spar; while the toughness so characteristic of certain magnesian rocks, and which shows itself by the difficulty met with in breaking up a sample into pieces is remarkable: it crushes, but does not readily

a dark grey. On the fresh surface of fracture of the specimen examined, hydrochloric acid produces a distinct effervescence, showing the presence of lime carbonate, apparently due to the alteration of some of the lime silicates present.

S N



South-North Section of Serpentine Bed on old Roadway about 100 yds. S. of the Windgate Quartzite.

1. Grit Bed.
2. ,, ,, 33 ins.
3. Coarse green Slate, 11 in.
4. Grit, 20 ins.
5. Serpentine passing into 6 (same as 3).
6. Coarse green Slate, 6 ins.
7. Grit, 23 ins.
8. Foliated or laminated hard Slate, showing wavy lines of foliation, 21 ins.
9. Grit, 24 ins.

Direction of Serpentine bed, N. 61° E. Dip, N. 56°.

Thickness of 5 and 6, 8 feet.

The chemical analysis of a specimen taken from the railway cutting was made by Miss M. W. Robertson, M. A., R. Un. Ir., and her Report thereof is as follows:—

I have examined the green-speckled rock, No. 29, which you submitted to me for analysis, and find that it contains the following substances:—silica; iron, present as FeO; alumina; magnesia; lime; and carbonic acid; also minute quantities of copper, nickel, and chromium; an exceedingly faint trace of cobalt and manganese. The alkalies, soda, potash, and lithia, are also present, but in very small quantity. The body fuses on being heated over the blowpipe.

In estimating the loss on ignition, allowance has been made for loss of CO_2, and also for the change from FeO to Fe_2O_3.

A quantitative analysis of the substance gives the following results:—

	per cent.
SiO_2	39·863
CuO	0·180
FeO	17·312
Al_2O_3	10·070
Cr_2O_3	1·299
NiO	0·112
CaO	6·380
MgO	11·838
Na_2O	1·289
CO_2	4·198
Loss of weight at 110° C.	0·430
,, ,, from 110° C. to 250° C.	0·129
,, ,, above 250° C.	7·854
	100·954

It is quite true that the composition here given differs from that of normal serpentine, in which the MgO is rarely under 25 or 30 °/° ; but Justus Roth, in his work, "Die Gesteins-analysen," gives at p. 56 the following analysis:—

No. 5. Nanzenbach near Dillenburg (analysed by Schnabel; extracted from Rammelsberg's "Handwörterbuch Mineralch." Suppl. 4, 200, 1849), a very soft serpentine, oil-green colour.

SiO_2	41·70
Al_2O_3	7·04
Fe_2O_3	——
FeO	26·95
MnO	——
CaO	3·34
MgO	10·26
K_2O, Na_2O	——
H_2O	11·58
	100·87

Dried to 100° C.; lost thereby 5·28 °/₀ H_2O.

Contrasting this analysis with Miss Robertson's, we have the following:—

	Bray Head Serpentine.		Dillenburg Serpentine.	
SiO_2	39·863		41·70	
Al_2O_3	10·070		7·04	
Cr_2O_3	1·299		—	
FeO	17·212		26·95	
CaO	6·380		3·34	40·55
MgO	11·838	35·822	10·26	
CuO	0·180		—	
NiO	0·112		—	
Na_2O	1·289		—	
CO_2	4·198	12·611	—	
Loss by ignition counted as H_2O	8·413		11·58	
	100·954		100·87	

In the Dillenburg analysis the sum of the protoxides, amounting to 40·55, represents about the normal amount of magnesia present in the noble serpentine. The same sum for the Bray Head mineral, representing 35·822, which is about the mean between the extreme amounts given by Dana in his list of analyses, for the MgO. It is therefore reasonable to assume that the protoxides replace magnesia.

As to the nature of the rock from which the serpentine is an altered product, I have not yet had time to determine; but, judging from the texture of the rock as seen in the spotted samples, it is probably a diabase porphyry, of the group of which the Lambay porphyry is the highest type.

If this rock be admitted to be a true serpentine, only now determined to be such, and if it may present different textures and appearances, it is quite evident that many such beds may exist in the Co. Wicklow awaiting recognition and determination. That such is the case is my belief; and from the examination that I have been making of the Bray Head rocks, I am convinced that some of the hard, slaty bands and olive-green slates may on examination turn out to be altered intrusive rocks. In support of this proposition I hope to be able to submit a further Paper to the Academy, embodying the results of the analyses made by the aid of the grants received from the Academy.

As regards the direction of the beds on the old road above the path, as given in the sketch of the section at that point, *see* page 508, I

may point out that, while the direction as stated by the Survey Memoir is roughly given as N.E./S.W., the true bearing is N. 61° E., while that of the fault by which it is dislocated is N. 57° E. (dip S. 70°) where determined, that is on the railway side; the difference being only 4°, it is probable that both directions are the same. The interest of exact measurements in this case is, that taking both directions at the value N. 61° E., we have very correctly the line of the southern coast of Ireland, as also that of the faults shown as existing in the Kilkenny coal-field, both of which I brought before the Academy in the Paper written to prove the importance of coast-line directions on the physical and geological structure of a country. The inspection of the map of Ireland shows that this direction manifests itself in a series of faults and lines of structure extending between the south coast and a line parallel to it passing through the mouth of the Shannon.

XXXV.

ON THE RANGE OF FLOWERING PLANTS AND FERNS ON THE MOUNTAINS OF IRELAND. By Henry Chichester Hart, B.A., F.L.S.

[Communicated by A. G. More, M.R.I.A.]

[Read June 9, 1890.]

The following remarks are the result of seven or eight years' botanizing in the Irish mountains. In carrying out these explorations, I was indebted to the Royal Irish Academy for assistance and for the ultimate publication of the various Reports on Districts with which I furnished them (*vide* p. 570). Other observations of my own are embodied in this summary, and I have gleaned what plant altitudes were of service from the *Cybele Hibernica.* A Report on the Ben Bulben plants, by R. M. Barrington, published in these *Proceedings* (Vol. iv., Ser. ii., p. 493), has also been made use of. For about nine-tenths of the total observations, I am solely responsible.[1]

My altitudes were taken invariably with the same pocket aneroid, an excellent one by Messrs. Troughton and Simms. I kept another in harmony with it, leaving it behind, and checking for diurnal variations by it on my return each day, but I was usually able to check my work at intervals during the day by means of the excellent Ordnance Survey maps (inch to the mile), which I was never without. Working a mountain, I would, of course, repeatedly reach the summit—a known height—and usually, also, I had mountain lakes, with a given altitude as a basis. Thus I could hardly err more than to a slight extent in most instances, especially as the Alpines, which were carefully attended to, commonly occur in the wet rills and declivities overhanging such lakes.

I cannot pretend either to have developed any interesting generalization, nor yet that I have exhausted the subject. Possibly some one better able to theorize may derive some slight assistance in the climato-

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[1] Since the present Paper was written, the *Flora of North East Ireland*, by Messrs. Stewart and Corry, has been published. From it I have extracted some thirty observations relating to that district.

logical bearings of plant-distribution from my records. If so, my object will be attained. And probably any mountaineering botanist will find it easy to make additions and corrections to my notes in many cases. In that case, the fact of my having incited others to such observations will remain always a source of satisfaction; for it is my belief that a considerable degree of accuracy is attainable in this direction, and that plants maintain their mountain strongholds, surrounded, as they are, by serried ranks of foes and sentries with rigorously limited precision. I mean in the majority of cases. Waifs and strays, seedlings, and annuals are beside the question. These are the exceptions which prove the rule. Those who have the ground hold it; and with the exception of an exceedingly slow and gradual diminution of Alpines in some stations, which is not improbably taking place, in all likelihood the plants on the hill and cliff-sides are as constant to their altitudes as the hills and cliffs themselves. This is true, of course, only so far as mankind, either by marauding or by drainage, or some other form of interference, does not alter the natural state of things. Nor is it to be deemed incorrect because of natural accidents, which occasionally, in a limited way, disturb the regularity, as when a saxifrage is found far below its natural limit, because it has been carried down by a torrent to a situation which it could not maintain longer than the first occasion upon which the torrent happened to make for itself another course. Again, a block of soil with Alpine vegetation may drop down a cliff, loosened by winter frosts, and for a few years introduce a group of strangers to an uncongenial situation, where they may flourish for a period, and where some few may actually become established. Those who do will probably be found elsewhere less open to any charge of intrusion at a similar altitude.

Some counties of Ireland have received less attention than I could have wished. I have very few records from Antrim, where, however, there are no mountains up to two thousand feet. From Wicklow, also, I would have wished a wider series of observations; but Wicklow, though chiefly mountainous, yields less of botanical interest than any other mountainous county in Ireland. Its wide-stretching deserts of upland bog, heather, and turf are often extraordinarily devoid of any sort of attraction for many miles at a time, and where broken ground and lovely scenery occur in Wicklow it is nearly always at low altitudes, unsuitable for mountain plants; so that the absence of records from Wicklow must be in part attributed to the lack of material for observation. I am probably as familiar with the Wicklow mountains as anyone, and I have spent weeks

amongst them making hardly a note; nevertheless more copious information about the vertical ranges of the commoner plants in that county is desirable.

The species dealt with in this Paper are those which somewhere or other in Ireland reach the altitude of five to seven hundred feet above sea-level, or upwards. All those that can only exist below this height, even in the most southern counties, are excluded from my list, and any that reach it, such as the arbutus, in one situation on the MacGillycuddy's Reeks, are included. Of course those species that can ascend a mountain to a certain height in Donegal will be readily conceived capable of ascending to a greater altitude in the milder climate of the Kerry mountains. The bracken, for instance (one of Watson's typical illustrations), has a difference of about eight hundred feet of vertical range in these two counties. Our insular climate is too equable, however, to admit any very marked and constant difference; and with regard to lowland species travelling upwards the contrast is, perhaps, greatest between Kerry and either Down or Wicklow.

With regard to the Alpine species—those which cannot exist at the lower levels, and descend towards the plains only a limited distance—these appear to be more constant, and present a wider degree of contrast. The mean height at which the Alpine plants which occur in Kerry occur also in Donegal will be found to be about eight hundred and fifty feet higher in the former district than in the latter, and in this direction comparisons and tabulated averages appear to be of interest, the more especially as on account of the limited number of so-called Alpine species occurring in Ireland, their range is easily exhibited.

It may be asked why I stopped at seven hundred feet, or rather why I came so low down the mountains before stopping. It was because I believed I observed that height to be somewhere about the upper limit of cultivation of grain crops in the mountain regions throughout the island, and therefore, above that altitude, weeds of cultivation and colonists are eliminated. In Kerry and Donegal and Connemara an elevation of seven hundred to eight hundred feet places one at once above a host of species properly belonging only to cultivation such as hemp-nettle, dead-nettle, sow-thistle, corn-cockle, corn-spurrey, *et hoc genus omne.* And this height approximates pretty fairly to the difference between the north and south of Ireland, if we contrast uppermost of lowlands and lowermost of Alpines in each case.

It is, however, not my intention to endeavour to make deductions: certain general laws will be observed to present themselves, and it is at

any rate desirable that the results collected here from my scattered Papers should be epitomized and rendered available. In several cases interesting comparisons may be made with the altitudes found in the *Cybele Britannica*, showing that a few Alpines, such as *Salix herbacea*, *Carex rigida*, *Saxifraga stellaris*, and one or two others, are less Alpine, and descend to lower lèvels in Ireland than anywhere else in the British Isles, apparently even in the Scotch highlands and islands. This may be supposed a consequence of our cloudier and more tempered summer time. Similarly, some lowland plants ascend higher; those will be more fully noted further on.

I give a list of the counties and their mountains dealt with, as arranged by me, in districts. I cannot claim to have examined all the summits; but I think above two thousand feet I have left very few unexamined in the south, and a lower height was necessarily explored in the north. Most Alpine species require a considerable mass of mountain ground above their stations in order that surface moisture may be present. *Salix herbacea*, *Carex rigida*, and *Lycopodium alpinum* are notable exceptions to this rule. As a result of this it will be found that although the mean height in Kerry at which all Kerry Alpines occur is about two thousand two hundred feet, yet there will seldom be found more than two or three Alpine species on those mountains which do not reach several hundred feet higher. A similar mean in Donegal is under eleven hundred feet, and there are no groups of Alpines to be found except when the summits reach some six or seven hundred feet or more above that height.

The total number of plants designated as "Alpine" in Ireland is thirty-one, and the total number of species here dealt with is four hundred and twenty-one. The latter total may be taken as corresponding with Watson's zones 3, 4, and 5 (see *post*, p. 560); but it must be understood that no close comparison of ranges in our limited space and vertical height can be made with those dealt with by Watson in Great Britain without danger of fallacious and unreliable deductions.

I will now enumerate and define the mountain districts of Ireland:—

I. KERRY AND CORK.—Lat. 51° 20′ to 52° 20′. SOUTH-WESTERN.

(*a*) The MacGillycuddy's Reeks, Carn Tual, 3414 feet, the highest point in Ireland. Other summits in this range are—Beenkeeragh, 3314 feet; Caher,

3200 feet; Cummeenapeasta, 3000 feet; and a ridge of about the same height for several miles.

(*b*) Brandon, 3127 feet.
(*c*) Caherconree, or Slieve Mish range, 2796 feet.
(*d*) Sugarloaf and Cloon Lough Mountains, 2440 feet.
(*e*) Mangerton and Killarney Mountains, 2754 feet.
(*f*) Hungry Hill and Glengariff Mountains, 2249 feet.

II. South Tipperary and Waterford.—Lat. 52° 10′ to 52° 28′. Median (longitudinally):—

(*a*) Galtee Mountains, 3015 feet.
(*b*) Knockmeildown Mountains, 2609 feet.
(*c*) Commeraghs, 2597 feet.

III. Wexford and Carlow.—Lat. 52° 26′ to 52° 38′. Eastern.

(*a*) Mount Leinster, 2610 feet.
(*b*) Blackstairs, 2409 feet.

IV. North Tipperary and Queen's County.—Lat. 52° 44′ to 53° 5′. Median:—

(*a*) Keeper, 2276 feet.
(*b*) Slieve Blooms, 1733 feet.

V. Wicklow and Dublin.—Lat. 52° 47′ to 53° 35′. Eastern:—

(*a*) Lugnaquilla, 3039 feet.
(*b*) Mullaghclevaun, 2783 feet; Gravale, 2352 feet; Tonelagee, 2684 feet; Duff Hill, 2364 feet; Douce, 2384 feet.
(*c*) Kippure, 2473 feet; Glendoo, 1929 feet; Seefingan, 2384 feet.

VI. Mayo, Galway, and Clare.—Lat. 52° 40′ to 54° 46′ Western:—

(*a*) Nephin, 2646 feet.
(*b*) Newport Mountains (Buckoogh, &c.), 2295 feet.
(*c*) Nephinbeg Range (Erris Mountain), 2369 feet.
(*d*) Achill and Curraun Achill, 2204 feet.
(*e*) Croaghpatrick, 2510 feet.
(*f*) Mweelrea Group, 2688 feet.
(*g*) Maamtrasna Group, 2239 feet.
(*h*) Maamturk Range, 2300 feet.
(*k*) Twelve Pins, 2395 feet.

VII. LOUTH AND DOWN.—Lat. 54° to 54° 10′. EASTERN :—

(*a*) Carlingford Hills, 1935 feet.
(*b*) Mourne Mountains, 2796 feet.

VII. SLIGO AND LEITRIM.—Lat. 54° 15′ to 54° 30′. WESTERN :—

(*a*) Truskmore, 2113 feet; Annacoona, 1963 feet; Ben Bulben, 1722 feet, &c.
(*b*) Arroo Mountain, 1712 feet; Largydonnell, 1712 feet, &c.

IX. DERRY, NORTH TYRONE AND ANTRIM.—Lat. 54° 45′ to 55° 19′. NORTH-EASTERN :—

(*a*) Mullaghmore, 1825 feet; Ben Bradagh, 1535 feet; Ben Evenagh, 1260 feet.
(*b*) Sawel and Dart (Sperrin Mountains), 2240 feet.
(*c*) Slievenanee, 1782 feet; Trostan, 1810 feet; Slemish, 1437 feet.

X. DONEGAL.—Lat. 54° 30′ to 55° 25′. NORTH-WESTERN :—

(*a*) Innishowen Mountains; Slieve Snacht, 2019 feet; Bulbin, 1630 feet.
(*b*) Muckish, 2197 feet; Errigal, 2466 feet; Dooish, 2147 feet; Loughsalt, 1546 feet; Slieve Snacht West, 2240 feet.
(*c*) Slieve League, 1972 feet; Slieveatooey, 1515 feet; Aghla, 1901 feet
(*d*) Blue Stack Mountains, 2219 feet.

The accompanying Table deals only with the so-called Alpine species in Ireland. All of these find lower limits in the south-west of Ireland, except *Juniperus nana* and *Sedum rhodiola*. *Sedum rhodiola* becomes rare, or absent, on the east coast, and is thoroughly Alpine in Tipperary.

LIST OF PLANTS OCCURRING

['×' signifies that the Plant occurs in district,

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Thalictrum alpinum,	3000	..	..	..	..	2110 1300
T. majus (flexuosum),	..	..	..	..	..	1000?
T. minus (including montanum and dunense),	} 2080	2000	..	..	×	1800
Anemone nemorosa,	×	×	×	×	2850	×
Ranunculus hederaceus,	720	700	1000	×	×	×
R. flammula,	1550	2500	×	×	1500	1850
R. ficaria,	2350	1540	×	×	×	×
R. repens,	2550	2000	×	×	2850	1590
R. acris,	2950	2000	×	×	×	2100
R. heterophyllus,	×	1250	×	×	×	×
R. bulbosus,	×	×	×	×	×	×
Caltha palustris,	×	1500	×	×	×	×
Nymphæa alba,	800	×	×	×	×	350
Nuphar lutea,	800	×	×	×	×	×
Meconopsis cambrica,	..	1300	..	×	×	1500
Nasturtium officinale,	×	×	×	×	×	500
Arabis hirsuta,	×	×	?	?	×	1200
A. thaliana,	×	..	×	..	×	..
A. petræa,	..	2850 2640	..	..	..	..
Cardamine hirsuta,	2550	1750	×	×	×	2100
C. pratensis,	2940	2500	×	×	×	1450
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

ON IRISH MOUNTAINS.

but not above 500 feet, or not noted.]

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
..	1950 1600	..	2150 900	Discovered on Brandon in 1887 by Mr. Colgan. I am not sure if the height is quite correct.
×	1300	..	×	
1600	1600	×	..	Descends to low levels in rocky places round mountains.
1800	×	1450	×	Insufficient observation.
×	×	600	1000	
1450	1850	1450	2000	
1500	×	×	1500	
×	×	×	1600	
×	1850	1450	1600	
×	×	×	×	
×	×	×	600	
×	1050	×	700	
×	×	700	1000	
×	×	700	700	
1000	1300	×	..	
×	×	800	850	
×	1000?	1200	×	
×	..	1000	..	
..	1500 1330	..	..	Barren on Galtymore. This is the most southern locality in Britain. Specimens from Galtymore have flowered after six years' treatment in the College Botanic Gardens.
×	×	1450	×	
×	1600	1800	2150	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeildowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Draba incana, ...	2550 3380	..	..	..	..	..
D. verna, ...	×	×	×	1000	×	×
Cochlearia officinalis, . .	3100 1500	2000 1850	..	..	×	×
Subularia aquatica, . .	1250	..	..	..	1400	1205
Viola palustris, . . .	2550	2000	×	×	2500	×
V. tricolor, ...	×	×	×	×	×	×
V. sylvatica, ...	3200	×	×	×	2000	2150
V. curtisii, ...	×	..	..	..	×	700
Drosera rotundifolia, . .	1050	900	×	700	1650	1100
D. anglica, ...	850	..	..	..	..	750
D. intermedia, ...	×	..	..	..	..	750
Parnassia palustris, . .	..	×	×	×	×	×
Polygala vulgaris, . .	2500	1150	×	×	×	1590
Elatine hexandra, ...	1126	..	..	..	..	×
Silene maritima, ...	1400	..	..	..	×	2500
S. acaulis, ...	..	..	..	..	..	..
Lychnis flos-cuculi, . .	1425	1470	×	×	800	700
L. diurna, ...	×	1700	×	×	×	..
Sagina procumbens, . .	1550	1200	..	..	1300	1650
S. subulata, ...	1650	..	..	..	..	1970
Alsine verna, ...	800 ?	..	..	..	..	×
Arenaria ciliata, ...	..	..	..	..	..	..
Stellaria media, ...	2550	2100	×	×	×	×
S. holostea, ...	×	1850	×	×	1300	×
S. graminea, ...	×	1350	×	×	×	×
S. uliginosa, ...	2300	3000	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
..	1950 0	1150 0	×	The Kerry locality is the most southern in the British Isles.
1200	×	×	×	
×	1900 1000	×	600	Var. *alpina*, the mountain form is indistinguishable from the seashore plant which re-appears in alpine situations.
×	..	×	+ 800	
×	×	1800	2000	
×	×	700	×	
2796	1700	1450	2000	Chiefly var. *Riviniana* on the mountains, but *Reichenbachiana* occurs also, as on Mweelrea in Mayo.
×	×	×	×	Sea cliffs of Moher.
1550	×	1130	1700	
×	400	×	750	
×	×	×	600	
×	1350	700	×	
×	1700	700	925	Including var. *depressa*, which is the commonest mountain form, and ascends the highest.
×	..	×	×	
×	1550	1150	1500	A maritime species reappearing on the mountains with alpines.
..	1600 1100	1150 900	550	The seacoast locality, Dunaff Head in Donegal, is lower than any south of Shetland?
×	×	×	1700	
×	1800	1000	×	
1320	..	1450	1700	
..	..	×	600	Apparently confined to sea-coast cliffs and high mountains in alpine or sub-alpine situations in Ireland.
..	..	1450	×	
..	1950 1200	..	..	The only British locality.
×	×	2200	1600	
×	×	×	×	
×	1050	500	×	
1900	×	1400	2050	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Cerastium triviale, . . .	3127	2500	×	2000	3000	2450
C. semidecandrum, . . .	×	..	..	..	×	×
Hypericum pulchrum, . .	2440	2000	×	×	×	2000
H. androsæmum, . . .	2080	1300	×	×	×	850
H. perforatum, . . .	×	×	×	×	×	×
H. humifusum, . . .	×	×	×	×	×	×
H. elodes, ...	975	700	500	×	800	×
Geranium robertianum, . .	1000	1600	×	×	1300	×
G. lucidum, ...	×	×	×	?	×	×
Linum catharticum, . .	500	1500	×	×	×	1100
Radiola millegrana, . .	700	×	..	..	×	×
Oxalis acetosella, . . .	2550	2000	×	×	2950	2200
Euonymus europæus, . .	×	×	×	×	×	×
Ulex europæus, . . .	1470	1250	×	1400	1600	×
U. galii, ...	2200	1400	1450	×	2150	×
Sarothamnus scoparius, . .	×	800	×	1200	×	×
Trifolium repens, . . .	1650	1700	×		×	1430
T. pratense, ...	×	1000	×	×	×	×
T. medium, ...	×	×	..	..	×	×
Lotus corniculatus, . .	800	1200	×	×		1200
L. major, ...	700	1000	500	×	×	×
Anthyllis vulneraria, . .	×	×	×	×	×	×
Vicia sylvatica, . . .	×	×	..	..	×	×
V. cracca, ...	×	1200	×	×	×	×
V. sepium, ...	1100	1000	×	×	×	1850
V. hirsuta, ...	500	×	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 4[illegible] 53° Eas[illegible]	53° 40′ to 54° 16′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS
×	1850	1450	1600	
×	×	1150	×	
×	×	1450	1100	
×	900	×	1400	
×	×	1200	×	
×	×	1000	×	
×	×	×	×	
×	1700	×	650	Exceptional height on Ben Bulben due to limestone.
×	×	600	×	
×	×	1450	700	Derry height due to trap.
×	×	×	400	
2200	1600	1450	1600	
×	575	×	×	
820	×	1450	×	Derry height due to trap.
1600	×	×	..	Watson's highest in Great Britain is 750 in Lake District.
×	×	×	700	
×	1550	1450	×	
×	×	1150	×	
×	..	1000	750	
×	1500	1500	×	This, like several other lowland species, is enabled to ascend to a higher elevation where the soil is due to limestone or basaltic trap.
×	×	×	×	
×	×	1150	600	
×	1350	700	×	
×	×	×	×	
×	1300	×	700	
×	×	×	×	
52° 4[illegible] 53° [illegible] Ea[illegible]	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeildowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Lathyrus macrorrhizus, . .	1350	1600	×	×	1300	1520
Prunus spinosa, ...	×	700	×	×	×	×
P. padus, ...	..	..	..	..	?	×
Spiræa ulmaria, . .	2800	1500	×	×	×	1100
S. filipendula, ...	..	..	..	..	..	550
Alchemilla vulgaris, . .	2100	1850	×	×	2300	1800
A. alpina, ...	2800 2200	..	..	..	+2000	..
A. arvensis, ...	1300	1250	×	×	×	775
Potentilla tormentilla, . .	3120	2850	2600 ?	2278	3000	2680
Comarum palustre, . .	800	1500	×	×	×	700
Fragaria vesca, . . .	500	1400	×	1000	1300	×
Rubus saxatilis, ...	×	..	..	900	×	1650
R. chamæmorus, ...	..	..	..	..	..	..
R. idæus, . . .	×	1700	×	×	1150	×
R. discolor, . . .	×	1600	×	×	×	×
R. fruticosus, ...	1100	×	×	×	1150	750
Dryas octopetala, ...	..	..	..	..	..	1220 0
Geum urbanum, ...	×	×	×	×	×	×
G. rivale, ...	2800	2000	×	×	×	2400
Rosa canina, ...	×	×	×	×	×	×
R. spinosissima, ...	×	×	×	×	×	1550
R. tomentosa, ...	×	×	×	1000	×	×
Cratægus oxyacantha, . .	850	1600	×	1200	1250	×
Pyrus aucuparia, ...	2300	2000	1900	1400	1420	2300
P. aria, ...	×	..	..	..	×	×
Peplis portula, ...	×	1250	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
×	×	1500	1550	
×	1200	550	800	
?	×	×	500	
×	1700	×	700	
..	..	..	..	
×	1850	1700	1400	*A. montana*, Willd. is included here. I doubt its being constant, but only stunted.
..	..	..	..	Confined to more alpine stations in Ireland than in Great Britain, but the Kerry locality (Brandon) is the most southern. *A. alpina* is absent from Wales. In Skye this species descends to sea-level, and often forms the sward, as it does upon the upper parts of Ben Lawers (3986 ft.) in Scotland.
1200	×	×	750	
2796	2118	2000 ?	2460	
×	×	×	1000	
×	×	1450	950	
980	1650	1000	1800	
..	..	+ 2000 ?	..	Not found, I think, since 1826. I searched for it without success in 1883. The only Irish locality.
1000	1400	1600	800	
×	×	×	×	
×	×	1300	950	Segregates not distinguished. The bramble series is very poorly represented in Ireland, except perhaps in the north-east.
..	1220 800	1150 1100	+ 1310	
×	×	×	500	Dryas occurs at sea-level in Galway and Clare. It is an alpine species occurring from York to the Highlands in Great Britain, but not so far south as in Ireland, and at greater altitudes.
×	1700	×	×	
×	×	1000	800	
×	1300	1450	800	
980	×	600	800	
×	1200	(1450)	×	Perhaps planted in exceptional Derry height.
1930	1850	1500	1650	Sometimes these upper heights are merely seedlings, and should perhaps be omitted.
?	920	900	×	The Ben Bulben *Pyrus aria* is var. *rupicola*.
×	×	×	×	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Epilobium angustifolium,	..	..	..	..	?	..
E. alsinifolium,	..	..	..	..	..	..
E. palustre,	1425	2500	×	×	×	1850
E. montanum,	×	1900	×	1000	×	1500
E. obscurum,	×	×	×	×	×	600
Circæa intermedia,	..	..	..	..	..	×
C. lutetiana,	×	900	×	×	×	×
Myriophyllum alterniflorum	1780	×	×	×	×	1285
Montia fontana,	1950	2850	×	×	×	1050
Lepigonum rupicola,	×	..	..	..	×	700
Spergula arvensis,	×	×	×	×	×	×
Sedum rhodiola,	3150	2500 1850	..	..	..	2600
S. anglicum,	2650	1250	×	×	1950	800
Cotyledon umbilicus,	940	1420	1450	1500	1450	630
Saxifraga umbrosa,	3370	2600 500	..	..	..	2680
S. geum,	2650	..	..	..	..	..
S. stellaris,	3400 1050	3000 1200	..	..	2850 1200	2450 1050
S. aizoides,	..	..	..	..	..	..
S. hirta (including affinis, sternbergii, cæspitosa, decipiens),	3150 1600	2570 2000	..	..	..	1500 1450
S. sponheimica (including platypetala),	..	2530 1100	..	..	..	..
S. hypnoides,	..	..	..	..	..	1000 ?
S. nivalis,	..	..	..	..	..	..
S. oppositifolia,	..	..	..	..	..	2400 1000
Chrysosplenium oppositifolium,	2700	3000	×	×	1300	2100
Hydrocotyle vulgaris,	800	1000	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
..	1650 1000	1100	×	
..	1200 1000	..	..	The only Irish locality.
1150	1500	1350	2000	
×	1600	600	800	
×	×	×	×	
?	1200 600	×	600	
×	×	×	×	
×	×	×	1180	
1320	900	1800	2050	
×	×	×	600	
×	×	600	×	
..	1850 1100	1300	1900	*Sedum rhodiola* occurs at sea-level from Kerry round the west and north coast to Antrim; in Kerry at Brandon promontory. Alpine in Great Britain; but also at sea-level in Scotland.
×	×	1150	850	
1500	500	1000	×	
..	..	..	2000 800	*S. umbrosa* is often barren at low levels in Donegal on mountains, and does not occur by the coast. Dickie records a few barren plants in Innishowen at 100 feet, but it may have been introduced. I could not re-discover them.
..	..	..	..	
2250 2000	..	1780 ?	2200 500	*S. stellaris* descends by a stream on the reeks to 750. It is more alpine in Scotland than in Ireland.
..	1800 350	500 to ?	1650 650	
..	..	..	+ ×	Typical *S. hirta* occurs in all these localities as well as other forms. The only seashore (or nearly so) locality for the alpine 'hirta' is that of Aranmore, Donegal, at 100 feet. *S. cæspitosa* I have only gathered in Galway.
..	1200 600	1450 1000	..	
..	×	×	×	Very near *S. sponheimica*, but distinguished by having bulbiferous axils. Watson is misleading about these forms.
..	1950	..	..	
..	1600 800	1150 1100	1850	Descends to the sea on maritime cliffs at Slieve League and Slieve Atooey in Donegal. Confined to the higher mountains in Wales and England, and Scotland, except the northern parts.
×	1600	2000	1850	
×	×	×	×	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeildowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Sanicula europæa, . . .	1000	1200	×	×	×	×
Helosciadium nodiflorum, .	×	800	×	×	×	×
H. inundatum, . . .	700	×	×	×	×	×
Carum verticillatum, . .	700	..	..	..	..	..
Bunium flexuosum, . .	×	×	×	1050	×	650
Angelica sylvestris, . .	2800	2500	×	×	×	2100
Heracleum sphondylium, .	×	×	×	×	×	×
Scandix pecten-veneris, . .	×	×	×	×	×	×
Chærophyllum sylvestre, .	1380	2400	×	×	×	×
Hedera helix, ...	1380	1600	×	×	1550	1740
Viburnum opulus, . . .	×	×	×	1000	×	×
Lonicera periclymenum, . .	1470	1600	×	×	1550	1550
Asperula odorata, . . .	×	×	×	850	×	×
Galium boreale, . . .	1200	?	..	..	..	1000?
G. saxatile, ...	3414	3015	2600	2278	3000	2640
G. verum, ...	×	×	×	×	×	×
Galium palustre, . . .	1550	1500	×	×	×	1205
Valeriana officinalis, . .	2650	2400	×	×	1300	1960
Scabiosa succissa, . . .	2650	1900	×	×	1750	2000
Tussilago farfara, . . .	×	1500	×	×	×	×
Bellis perennis, . . .	2380	1700	×	×	×	1250
Achillea ptarmica, . . .	×	×	×	×	×	×
A. millefolium, . . .	2380	×	×	×	×	2550
Solidago virgaurea, . .	3000	2600	2100	2200	2900	2600
Anthemis nobilis, . . .	1200	×	×	..	1500?	×
Chrysanthemum segetum, .	×	×	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	53° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	Observations.
×	907	×	950	
×	×	×	×	
×	×	×	×	
..	..	×	×	
×	1300	×	×	
×	1700	1450	1450	
×	1600	1450	×	
×	×	600	×	
×	1300	×	×	
..	1300	1150	700	
×	×	×	×	
×	×	1130	1050	
×	×	×	×	
..	..	×	×	Alpine in Great Britain, but seldom found on the Irish mountains, being chiefly confined to the rocky limestone districts, and on the shores of the larger lakes, where it is very abundant.
2796	2100	2300	2460	
×	×	(1200)	×	
×	×	×	1000	
×	×	×	1400	
1250	1750	1450	1800	
920	1700	×	×	
×	1950	1700	1350	
×	×	700	700	
×	×	1450	×	
2310	2100	2000	2100	
×	..	×	900	
×	×	700	×	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmealdowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Artemisia vulgaris, . .	×	×	×	×	×	×
Filago germanica, . . .	×	×	×	×	×	×
Gnaphalium uliginosum, .	×	700	×	×	×	×
G. sylvaticum, . . .	×	×	..	..	×	×
Antennaria dioica, . . .	2900	×	×	1600	×	2400
Senecio vulgaris, . . .	×	1500	×	×	×	×
S. sylvaticus, . . .	1010	×	×	×	×	×
S. jacobæa, ...	×	800	×	×	×	1630
S. aquaticus, ...	×	1000	×	×	1500	1205
Carlina vulgaris, . . .	×	×	..	850	×	×
Saussurea alpina, . . .	2380 / 1800	+ 2600	..	..	2050 / 1960	1700 / 1320
Centaurea nigra, . . .	1200	×	×	1000	×	×
C. cyanus, ...	×	×	×	×	×	×
Carduus lanceolatus, . .	720	×	×	×	×	×
C. palustris, ...	×	1200	×	×	1750	1370
C. pratensis, ...	×	×	×	×	1350	×
Hypochæris radicata, . .	×	×	×	×	×	×
Leontodon autumnalis, . .	3200	2500	×	×	1500	2500
Taraxacum dens-leonis, . .	2650	2000	×	×	×	2100
Sonchus oleraceus, . . .	950	×	×	×	×	×
S. asper, ...	×	×	×	×	×	×
Crepis paludosa, . .	?	2500	..	..	1750	1700
Hieracium pilosella, . .	×	×	1650	1200	1350	×
H. anglicum, ...	2500 / 1600	2000 / 1900	..	..	..	2150
H. iricum, ...	..	..	..	..	..	900
H. pallidum, ...	..	..	..	..	..	..
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
×	×	500	×	
×	×	×	650	
×	×	×	×	
×	×	500	650	
×	1700	2300	1800	
×	×	1150	×	
×	×	×	×	
×	×	1450	×	
×	×	×	600	
..	..	×	×	
..	..	..	2000 1000	An alpine species found further south in Ireland than in Great Britain, and at lower levels.
×	×	×	850	
×	×	600	×	
×	1400	1700	×	
920	1600	1350	850	
×	1950	×	900	
1500	1850	×	×	
2310	..	..	1300	Usually var. *Taraxaci* at upper altitudes.
×	1700	1450	2210	
×	×	×	×	
×	907	×	×	
×	1700	1200	1450	
×	1300	1300	×	
1920 1500	1300	1750	1700	α and β of Backhouse are here united as inseparable. The only hawkweed alpine in Ireland, and occurring farther south than in Great Britain.
..	1200	1000	×	
1500	1300	..	×	*H. iricum* is doubtfully separable from β of *Anglicum*.
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Hieracium cæsium, . .	..	..	..	..	..	..
H. flocculosum, . . .	..	..	..	..	..	..
H. vulgatum, . . .	1450 700	..	..	..	×	..
H. argenteum, . . .	..	..	..	..	..	1520 1100
H. corymbosum, . . .	..	..	×	..	×	..
H. umbellatum, . . .	×	..	×	..	×	..
H. boreale, ...	..	..	..	...	1300	..
H. murorum, ...	..	..	..	..	×	..
Lobelia dortmanna, . .	1280	..	..	..	1500	1205
Campanula rotundifolia, . .	3127	2530	×	×	2500	2600
Jasione montana, . . .	3127	2500	×	×	1300	2200
Wahlenbergia hederacea, .	×	..	..	..	750	..
Arbutus unedo, . . .	520	..	..	..	..	..
Andromeda polifolia, . .	?	..	..	×	1400	×
Calluna vulgaris, . . .	3300	3015	2600	2278	3000	2680
Erica cinerea, ...	2500 2200	2150	1900	2200	2450	2050
E. tetralix, ...	1950	1600	1000	..	1600	1290
Dabeocia polifolia, . . .	..	..	..	..	..	1900
Vaccinium vitis-idæa, . .	..	2200 2000	2300 2100	2000	2900 1800	†2400
V. myrtillus, ...	3414	3000	2600	2278	3000	2680
V. oxycoccos, . . .	× ?	× ?	..	×	×	×
Arctostaphyllos uva-ursi, .	..	..	..	..	..	1800
Pyrola media, . . .	..	..	..	..	..	1075
P. minor, ...	..	..	..	..	..	..
Ilex aquifolium, . . .	1350	×	×	×	1300	1250
Fraxinus excelsior, . .	×	×	×	1000	1300	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
..	..	1000	..	From N. E. Ireland flora.
1500	..	..	..	Do. Do.
1400	×	1100	×	The Mourne Mountain (Broughnamaddy) plant is a unique form, occurring also in S. W. Donegal. It will be described by Mr. Hanbury in his Monograph on British Hieracia.
950	..	..	×	
..	..	×	×	
×	..	1000 ?	×	The Derry (Ben Evenagh) height is taken from *Cybele Hibernica*. I did not, however, see it so high there. In West Donegal, where it is common, *H. umbellatum* rarely ranges up to 600 ft.
..	..	×	..	
..	..	1150	850	The above Hieracia have been determined by Mr. James Backhouse.
1500	..	×	1180	
2450	1300	1770	2219	
×	×	1000	1450	
..	..	..	..	
..	..	..	..	
×	..	×	..	
2796	2100	2200	2460	Does not quite reach summit of reeks 3414 feet. 3300 feet is upper limit in Scotland (Watson).
2050	1600	2200	1970	2190 feet is upper limit in Scotland (Watson).
1850	1700	1800	1800	2370 feet is upper limit in Scotland (Watson).
..	..	..	..	Same upper limit in Mayo and Galway.
2450 1900	..	1800 1100	1900 900	The only Irish Alpine that is decidedly rarer in the West. It has been confused by several writers with Arctostaphyllos in reports from localities.
2796	2100	2200	2460	
×	×	700	..	
?	..	×	1900	Has a more southern range in Ireland than in Great Britain.
..	..	×	700	
..	..	1000	..	From N.-E. Ireland flora.
1050	×	1130	700	
820	907	840	800	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Gentiana campestris,	×	×	×	×	×	×
G. amarella,	×	..	..	?	×	×
G. verna,	..	..	..	..	..	600
Menyanthes trifoliata,	1450	1000	×	×	×	1480
Lithospermum officinale,	×	×	?	?	×	×
Myosotis cæspitosa,	×	×	1000	×	×	×
M. versicolor,	×	×	×	1150	×	×
M. repens,	1010	1500	×	×	×	1370
Orobanche rubra,	..	..	..	..	..	×
Melampyrum sylvaticum,	..	..	..	..	..	..
M. pratense,	3150	2400	×	2278	2800	2600
Pedicularis sylvatica,	2700	2150	×	×	×	2050
P. palustris,	..	1000	×	×	×	×
Digitalis purpurea,	2250	2100	×	×	1800	1900
Veronica beccabunga,	×	×	×	×	×	×
V. scutellata,	1200	900	×	×	×	×
V. chamædrys,	2550	×	×	×	1350	1330
V. montana,	×	?	..	..	×	×
V. agrestis,	×	1300	×	×	×	×
V. arvensis,	×	×	×	×	×	×
V. serpyllifolia,	1780	1700	×	×	×	×
V. officinalis,	2250	1950	1450	×	×	850
Euphrasia officinalis,	2880	2400	×	×	2930	2390
E. odontites,	×	1330	×	×	×	×
Bartsia viscosa,	700	..	..	..	..	..
Rhinanthus crista-galli,	2380	2400	×	×	×	1630
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
×	×	1500	700	
?	..	700	×	
..	..	..	..	
1450	1400	×	2000	
×	×	700	×	
×	×	1800	×	Due to trap-rocks in Derry.
×	×	1300	×	Ditto.
×	×	×	850	
..	..	1000	×	
..	..	600	?	
2310	2100	×	2200	
×	1700	×	2150	
×	1050	1400	1300	
1500	1700	1250	1560	
×	950	×	×	
1150	×	1350	×	
×	×	1450	×	
×	..	1000	×	
×	×	×	×	
×	×	1200	×	
780	×	1450	×	
×	1600	1530	2050	
×	2000	1530	2400	
×	×	1300	×	
..	..	..	×	
980	×	1450	1300	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeildowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Sibthorpia europæa,	1700	..	..	..	..	..
Mentha aquatica,	×	×	×	×	×	650
Thymus serpyllum,	3230	×	×	×	×	2680
Scutellaria minor,	800	700	×	×	×	×
Prunella vulgaris,	1550	1700	×	×	×	1350
Galeopsis tetrahit,	720	×	×	×	×	×
Stachys palustris,	×	×	×	×	×	×
Ajuga reptans,	1350	1700	×	1300	×	×
Teucrium scorodonia,	1200	1600	×	1300	×	1250
Pinguicula grandiflora,	2250	..	..	..	..	..
P. vulgaris,	2450	×	×	×	2500	2050
P. lusitanica,	950	850	×	×	×	650
Utricularia vulgaris,	800	×	×	×	×	×
U. intermedia,	×	..	..	..	..	×
U. minor,	×	..	..	..	..	×
Primula vulgaris,	2650	1900	×	×	1750	1900
Lysimachia nemorum,	1800	1700	×	×	1600	1850
Anagallis tenella,	975	800	×	×	×	820
Armeria maritima,	3414	..	..	..	×	2640
Plantago lanceolata,	2380	×	×	×	1350	2550
P. maritima,	1250	..	..	..	×	2600
P. coronopus,	×	..	..	..	×	×
P. major,	×	×	×	×	×	×
Littorella lacustris,	1425	1850	..	..	×	1800
Atriplex patula,	720	×	×	×	×	×
Rumex obtusifolius,	720	1250	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ t[o] 54° 46′ Wester[n]

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
..	..	..	..	
×	×	×	×	
2050	1700	1700	1800	
..	..	..	..	
1150	1700	1750	1550	
×	×	700	×	
×	×	700	800	
×	×	650	×	
×	×	1200	1100	
..	..	..	..	
1700	1700	1650	1650	
×	×	1000	1000	
×	×	×	×	
..	..	×	500 ?	About 400 feet in Kerry, Mayo, and Galway; a little higher in Donegal. Aquatic plants seldom afford a criterion of climatic conditions.
×	×	×	850	
×	1600	1450	1600	
×	1100	850	1550	
×	×	×	700	
..	×	1000	2460	A maritime plant appearing inland on some of the higher mountains and on the shores of Killarney Lakes; also in low grounds in King's County.
×	×	1450	350	
×	1200	1000	1650	
×	×	1150	650	Exceptional Derry height due to warm nature of soil derived from basaltic rocks at Ben Evenagh.
×	×	1150	×	
1500	×	×	1050	
×	×	×	×	
×	×	1000	×	
4° to 4° 10′ ...stern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N.east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeildowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and
R. crispus,	×	×	×	×	×	×
R. nemorosus,	×	1000	×	×	×	×
R. acetosa,	3414	3000	2670	2278	3000	2680
R. acetosella,	3414	3015	2600	2278	3000	2680
Oxyria reniformis,	2150 1500	2600 1500	..	..	..	2400 1470
Polygonum aviculare,	×	700	×	×	×	×
P. hydropiper,	1010	1500	×	×	×	×
P. viviparum,	2380	..	..	..	..	..
Empetrum nigrum,	3300	2460	2600	2278	2950	2640
Euphorbia helioscopia,	×	×	×	×	×	×
E. peplus,	×	×	×	×	×	×
E. hyberna,	1800	×	..	..	..	900
Callitriche verna,	×	1500	×	1400	×	×
C. platycarpa,	×	1700	×	×	×	1370
C. hamulata,	1126	1000	..	..	×	1205
Urtica dioica,	×	×	×	×	×	×
Salix pentandra,	..	..	..	..	..	×
S. repens,	×	×	×	×	×	1200
S. cinerea,	1380	×	×	×	×	1350
S. aurita,	1350	1600	×	×	1750	1650
S. herbacea,	3050 1800	3000 2050	..	..	2950 2370	2600 1570
S. caprea,	×	×	×	×	×	×
S. phylicifolia	..	..	..	..	..	1010 550
Populus tremula,	×	×	×	×	×	×
Myrica gale,	1100	×	×	×	×	800
Alnus glutinosa	×	×	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40 54° 4 Weste

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
×	×	1500	×	From N. E. Ireland flora.
×	×	700	×	
2790	×	2200	2460	
2790	1800	2200	2460	
..	1950 1200	..	1800 900	*Oxyria reniformis* occurs in casual patches in Kerry at 1150 feet (Brandon), and 550 feet (Reeks). Not found so far south in Great Britain; but less Alpine in Scotland than Ireland. Occurs at about 700 feet on Ben Lawers, with *Polygonum viviparum* in upland meadows.
×	×	×	×	
×	×	×	900	
..	1200	..	1500 1310	Occurs accidentally on talus at Ben Bulben at 500 ft. The Kerry station is the most southern in the British Isles.
2796	2100	1700	2150	
×	×	1300	×	
×	×	1300	×	
..	..	..	..	
1320	×	×	×	
×	×	×	×	
×	..	..	1000	
×	1200	1150	×	
..	×	×	500	
×	×	1450	800	
×	×	×	800	
1100	2100	1200	1250	
2780 1680	1950 1700	1780 1200	2400 870	In Scotland this willow does not descend below Watson's mid-arctic zone. 1860 feet is the lowest elevation quoted in the *Cybele Britannica*. Dickie gives 1600 feet in the Orkneys. In Donegal it occurs at 900, 1000, 1100 feet, as well as 870 feet, which is an Innishowen record, and is the lowest in the kingdom.
×	1400	×	700	
..	1400	×	×	
×	×	650	700	
1050	×	1850	1000	
×	×	800	×	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N.east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Betula alba,	1380	×	×	1000	700	1500
Quercus robur,	×	1000	×	1000	×	750
Corylus avellana,	850	×	×	1000	1300	1100
Taxus baccata,	×	..	..	..	..	×
Juniperus nana,	1600	..	..	..	..	1800
Orchis maculata,	2800	2300	×	×	×	2400
O. mascula,	×	×	×	1000	×	×
O. latifolia,	×	×	×	×	×	1000
Habenaria viridis,	×	×	..	..	×	×
H. chlorantha,	700	×	..	..	×	×
H. bifolia,	×	×	..	..	×	×
Malaxis paludosa,	800	..	..	..	1200	×
Gymnadenia conopsea,	..	..	×	×	×	×
G. albida,	×	×?	..	..	..	600
Listera ovata,	×	×	×	1150	×	×
L. cordata,	1300	1800 1080	..	..	1800	1650
Iris pseudacorus,	×	×	×	×	×	860
Allium ursinum,	×	×	×	1000	×	×
Endymion nutans,	×	×	1100	1000	×	630
Eriocaulon septangulare,	1000	..	..	..	..	×
Narthecium ossifragum,	1550	2300	×	1600	2930	2050
Juncus effusus,	×	×	×	×	×	1920
J. conglomeratus,	2250	×	×	×	×	×
J. supinus,	2000	1850	×	×	×	1520
J. bufonius,	1010	800	×	×	×	×
J. acutiflorus,	1550	1500	×	×	×	×
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
920	×	840	850	
×	×	1480	700	
820	1200	840	800	
..	900	×	×	
2000	1200	×	1750	Chiefly Alpine, but occurs at sea-level along the west coast, and also at low levels on limestone, and by the larger lake-shores. Is the Irish form identical with the true *J. nana?* Hooker and Watson appear to decide against it. *J. communis*, the larger lowland form, occurs at lower levels.
2000	2100	×	1950	
×	×	1000	×	
×	×	700	×	
×	×	1000	×	
×	×	1000	×	
×	×	1000	×	From N. E. Ireland flora.
..	..	1000	..	
×	×	800	800	
×	×	800	800	
×	×	1000	1470	
2000	2000	1770	1900	
×	1100	550	730	
×	1050	×	×	
×	1350	×	×	
..	..	..	×	
1250	1700	1350	1400	
×	×	×	2150	
1550	1850	1700	1400	
×	×	1700	2200	
×	×	×	1100	
×	×	×	1050	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and SlieveBlooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Juncus squarrosus, . .	3300	2500	2600	2278	2500 ?	2680
Luzula sylvatica, . . .	3414	3000	2600	2278	2500	2680
L. campestris, . . .	3127	2300	2600	×	×	2680
L. multiflora, . . .	3070	×	×	×	×	×
L. pilosa, ...	..	..	..	..	500	..
Triglochin palustre, . .	×	1500	×	×	×	×
Sparganium natans, . .	1425	1000	..	..	..	1520
S. simplex, ...	800	..	..	×	×	×
S. ramosum, ...	×	×	×	×	×	×
Potamogeton polygonifolius, .	×	1500	×	×	×	980
P. natans, ...	1280	1700	×	×	×	1205
P. pusillus, ...	1600	×	×	×	×	×
Schœnus nigricans, . .	1400	×	×	×	×	1350
Rhynchospora alba, . .	1050	..	..	..	×	350
Eleocharis palustris, . .	×	1000	×	×	×	1205
E. multicaulis, . . .	1000	?	850	..	×	860
Scirpus savii, . . .	850	..	..	..	×	820
S. cæspitosus, . . .	3000	2278	..	..	2500	×
S. fluitans, ...	800	..	..	..	×	×
S. setaceus, ...	×	1250	..	..	×	×
Eriophorum polystachyon .	1425	×	2600	×	2800	2350
E. vaginatum, . . .	2776	3000	2600	×	2800	2680
Carex dioica, . . .	×	..	..	×	..	×
C. pulicaris, ...	2380	..	..	..	1300	2000
C. paniculata, . . .	1250	1900	..	..	×	×
C. stellulata, ...	3300	2600	2100	×	2000	980
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ t[o] 54° 46′ Wester[n]

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
1850	2100	2000	2150	
2796	2100	×	2460	
2350	×	×	2600	
×	2100	1500	2000	
×	..	550	600	
×	1100	×	1000	
..	..	×	2100	
..	×	×	×	
×	×	×	600	
1550	1550	1350	×	
1550	×	×	1180	
1150	×	×	×	
1320	×	×	1100	
600	×	×	1000	
1450	×	×	×	
1150	..	700	925	
..	×	×	×	
2450	2100	..	2300	
1150	..	×	×	
×	×	×	×	
1850	2100	2000	2200	
1850	2100	2000	1450	
1400	1650	×	750	
1500	×	1100	1700	
×	×	×	×	
1550	2000 ?	1800	2150	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Carex ovalis,	700	2200	×	1000	850	×
C. vulgaris,	1870	2500	×	×	×	2000
C. pallescens,	×	..	..	..	×	820
C. limosa,	800	..	..	..	..	×
C. panicea,	2550	1130	×	×	×	2400
C. præcox,	950	1500	×	×	×	×
C. pilulifera,	3120	2150	2100	1500	2500	2680
C. flava,	2650	2400	×	×	×	2050
C. hornschuchiana,	1450	..	..	1000	×	1000
C. glauca,	1950	1700	×	×	×	1900
C. binervis,	2470	2300	×	×	×	2680
C. lævigata,	700	..	500	..	×	×
C. sylvatica,	700	×	×	×	×	×
C. ampullacea,	800	1500	×	×	×	1520
C. rigida,	3050 3020	2450 2050	2600 2280	..	2950 2600	2600 1600
Anthoxanthum odoratum,	3030	2100	×	2278	3000	2680
Sesleria cærulea,	..	..	..	..	..	1000?
Nardus stricta,	3120	1500	×	×	×	2680
Arundo phragmites,	700	×	×	×	×	×
Agrostis vulgaris,	3414	3015	2600	2278	3000	2680
,, ,, var. pumila,	×	1850	×	×	×	380
A. alba,	1650	×	×	×	×	×
Holcus lanatus,	1010	1130	×	×	×	1325
Aira flexuosa,	3414	2800	2600	2278	3000	2640
,, cæspitosa,	2100	×	×	×	3000	2680
,, ,, var. alpina,	3100 2550	..	..	..	..	2600 2100
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
1550	×	500	×	
1450	×	1800	×	
×	×	×	×	
..	..	×	×	
1500	1700	1150	1160	
1500	×	×	1280	
2796	×	1850	2200	
1150	1850	×	1800	
1500	..	×	×	The Mourne mountain height is from N. E. Ireland flora.
1550	2000	×	1300	
1050	2100	2000	2000	
×	×	×	×	
×	1850	×	×	
1150	1400	×	1500	
2796 1650	2100 1700	2200 1750	2400 1000	In Scotland this sedge is more alpine than in Ireland; its mean lower limit would be higher. It is the commonest alpine species in Ireland, but at the same time it always maintains its position. I met with it once by Lake Scardaun below Nephinbeg in Mayo, as a casual, at 850 feet. Elsewhere the summit of Knockalla in Fanet, Co. Donegal, is its lowest limit at 1000.
1900	2000	×	1400	
..	1100	..	×	
1700	×	×	1850	
×	×	×	800	
2790	×	2200	2460	
..	..	..	1550	
×	×	×	1000	
×	×	×	×	
2790	2100	2200	2400	
×	×	×	1100	
..	..	..	..	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I: Kerry and (Cork).	II. Galtees, Commeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and Slieve Blooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Aira caryophyllea,	1010	×	×	×	×	×
A. præcox,	1800	×	×	×	×	×
Triodia decumbens,	1200	1230	×	×	×	1150
Cynosurus cristatus,	×	×	×	×	×	×
Kœleria cristata,	..	..	..	..	×	×
Molinia cærulea,	2250	1000	×	×	×	2000
Poa annua,	3127	3000	×	×	×	2510
P. trivialis,	1650	×	×	×	×	×
P. alpina,	3100	..	..	..	..	..
P. pratensis,	3000	2200	×	×	×	×
Glyceria fluitans,	1550	×	×	×	×	×
Dactylis glomerata,	1200	×	×	×	×	×
Festuca ovina,	3300	3015	2600	2278	3000	2680
Brachypodium sylvaticum,	850	×	×	×	×	×
Equisetum arvense,	×	×	×	×	×	×
E. hyemale,	..	..	..	×	×	..
E. sylvaticum,	×	1000	..	1600	×	1100
E. limosum,	1425	×	×	×	×	×
E. palustre,	×	..	..	×	×	2000
Cryptogramme crispa,	..	..	..	..	..	..
Polypodium vulgare,	2800	2400	2200	×	×	2380
P. phegopteris,	975	..	..	..	?	×
P. dryopteris,	..	..	..	..	×	..
Lastrea filix-mas,	3150	2850	2600	×	×	2380
L. oreopteris,	×	700	1100	×	800	×
L. dilatata,	3000	2500	2600	×	×	2640
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ t 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
1850	×	×	×	
1200	×	×	×	
1250	×	1450	1800	
×	×	1500	×	From N. E. Ireland flora.
..	2000 ?	1000	1500	
1050	×	×	1700	
×	×	2200	1600	
×	×	×	×	
..	1950 1500	..	..	Not found south of York (lat. 54) in Great Britain.
2796	×	×	1600	
×	×	×	1350	
×	×	×	×	
2796	×	2200	2460	
×	×	×	×	
×	1050	1000	×	
..	..	1000	×	From N. E. Ireland flora.
×	1200	500	700	
×	×	×	700	
×	1400	×	×	
2400 1700	..	1000	† 750	Very scarce in each locality. Only a couple of plants were found in Donegal near Ardara, and the parsley fern is similarly scanty in the Mournes and Carlingfords.
2310	×	1770	1100	
2250	..	×	2100	
..	800	1800	..	
×	1850	1770	1800	Usually var. *abbreviata* on the mountains.
×	×	×	800	
2310	2100	1770	2150	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 52° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

FLOWERING PLANTS AND FERNS.	I. Kerry and (Cork).	II. Galtees, Comeraghs and Knockmeldowns	III. Mt. Leinster and Blackstairs.	IV. Keeper and SlieveBlooms.	V. Wicklow.	VI. Mayo and Galway and Clare.
Lastrea æmula, . . .	2100	1230	..	×	×	1200
Polystichum lonchitis, . .	2800/2000	..	..	..	..	1500
P. aculeatum, . . .	2470	×	×	1000	1300	1500
Cystopteris fragilis, . .	3150/1400	2850/1850	..	†800	?	2400/1100
Asplenium adiantum-nigrum,	1500	×	×	×	×	1150
A. ruta-muraria, . . .	×	×	×	×	×	1150
A. marinum, ...	500	..	..	..	×	500?
A. viride, ...	3150/1850	2850/1500	..	..	..	1900/1470
A. trichomanes, . . .	2850	2200	×	×	×	1600
Athyrium filix-fœmina, . .	2650	×	×	×	×	1150
Pteris aquilina, . . .	1700	1720	1750	1100	1400	950
Blechnum boreale, . . .	3150	2500	×	×	2500	2250
Trichomanes radicans, . .	1000	×	..	..	..	..
Adiantum capillus-veneris, .	800	..	..	..	..	×
Scolopendrium vulgare, . .	×	1400	×	×	×	×
Hymenophyllum tunbrigense, .	1310	2500	×	×	..	1430
H. unilaterale, . . .	3300	2530	2600	×	2700	2590
Osmunda regalis, . . .	820	1000	×	×	×	900
Botrychium lunaria, . .	×	×	×	×	×	×
Ophioglossum vulgatum, .	×	1050	×	×	×	×
O. var. polyphyllum, . .	600/350	..	..	..	..	..
Isoetes lacustris, . . .	2338	1540	..	..	1400	×
Lycopodium selago, . .	3050	2600	2600	..	2800	2640
L. alpinum, ...	2000 ?	..	..	..	2400	2400/1550
L. selaginoides, . . .	×	..	..	..	×	2100
L. clavatum, ...	× ?	×	..	1400	1950	1900
	51° 20′ to 52° 20′ Western	52° 10′ to 52° 28′ Median	52° 26′ to 52° 38′ Eastern	52° 44′ to 53° 5′ Median	52° 47′ to 53° 35′ Eastern	52° 40′ to 54° 46′ Western

VII. Mournes and Carlingfords.	VIII. Ben Bulben and Glenade.	IX. Sperrins and Derry and Antrim.	X. Donegal.	OBSERVATIONS.
×	950	×	800	
..	1600 1150	..	1850 1470	Casual plants have occurred at low levels in Longford, Tyrone, and Donegal. Kerry is the most southern station in the British Isles.
×	×	×	950	
..	1700 1000	×	1800	
×	×	1600	1100	Derry height from N. E. Ireland flora.
×	1450	1150	900	
..	..	×	×	
..	1600 700	..	1600 700	
1500	×	1450	1800	
×	1750	1770	1600	
1450	..	1180	900	In II. and VI. isolated or exceptional patches were met with at about 250 feet higher, but the altitude quoted is the ordinary upper limit or nearest to it.
2250	2000	×	2150	
..	..	..	×	
..	700	×	×	
×	×	1200	500	
×	..	×	×	
1750	1850	×	2200	
×	×	×	700	
×	×	1750	×	
×	×	×	×	
..	..	..	700 800	
1500	×	×	1500	
2310	2100	1800	2400	
2796 2000	..	1850	2219 1400	
2020	1400	800	1800	
..	..	×	900	
54° to 54° 10′ Eastern	54° 15′ to 54° 39′ Western	54° 45′ to 55° 19′ N. east'rn	54° 30′ to 55° 25′ Western	

In the foregoing list 421 species are dealt with. That is to say there are that number of plants in Ireland occurring somewhere or other at an altitude of 500 to 700 feet or upwards above sea level.[1] Theoretically, if we take a species which reaches that height only in the southern counties with a milder climate, it should not ascend above sea level in the northern counties at all. And further, a plant which reaches that height in the extreme north of Ireland should ascend to about double the altitude in the south. These observations relate to the lowland not the alpine species, that is to say, to those with an upper limit, but no lower, in Ireland. And it has been remarked already that the Irish alpine species indicate that this climatic difference between the south-west and north-east of Ireland is somewhere about 800 feet, perhaps 1000 in extreme cases.

Let us see from the list whether any number of species from the plains follow this law. Thoroughly marsh-loving or aquatic species should not be used as test species since they are far more ubiquitous, in consequence of being less dependent on atmospheric effects than the rest.[2] In selecting these examples it is not, of course, necessary to adhere only to those at or about the 600 feet height. What we are seeking for is the difference; whether this be evidenced by the disappearance of the species altogether from the mountains in the north, or by whatever altitude it decreases or varies from south to north.

From the diagram of alpines [*see* Table], it will be seen, that taking Donegal as the base line, the mean alpine heights in the remaining mountain districts increase in the following order:—X, 0; IX, 231; VIII, 377; VII, 1000; VI, 309; V, 945; IV, 1100; III, 1190; II, 1080; I, 855.

Of these, IV. (Blackstairs and Mount Leinster) hardly deserve consideration, so few are the species therefrom. At the same time it is my belief that, *if there were* mountains in that district containing alpine plants, the latter would occur at a higher level there than elsewhere in Ireland.

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[1] There is, generally speaking, on any mountain a difference of about 200 or 300 feet in the altitude to which lowland plants ascend on the north and south sides, the latter being of course the highest. It was for this reason that my lower limit wavered between 500 and 700 feet.

[2] Thus in a lake in Donegal, *Typha angustifolia*, and *Myriophyllum verticillatum* grow side by side with *Callitriche autumnalis*, *Isoetes lacustris*, *Sparganum natans*, and *Potamogeton filiformis*; two groups of species whose juxtaposition would be quite unprecedented were it not for the equalizing influences of aquatic life.

Dealing with the tabulated plants in order, we have as follows on page 518–20 :—

Ranunculus ficaria, . .	decreases	850	from	I.	to	X.
R. repens, . . .	,,	950	,,	,,	,,	,,
R. acris, ...	,,	1350	,,	,,	,,	,,
R. heterophyllus, . .	,,	1250	,,	II.	,,	,,
(*Caltha palustris*, . .	,,	800	,,	,,	,,	,,)
(*Nuphar lutea*, . .	,,	800	,,	I.	,,	,,)
Cardamine hirsuta, . .	,,	1150	,,	,,	,,	IX.
C. pratensis, . . .	,,	790	,,	,,	,,	X.
Viola sylvatica, . .	,,	1200	,,	,,	,,	,,
Polygala vulgaris, . .	,,	1375	,,	,,	,,	,,
Elatine hexandra, . .	,,	700 ?	,,	,,	,,	,,

So far *Drosera rotundifolia*, *D. intermedia*, and *Parnassia palustris*, present notable exceptions.

On page 520–22 :—

Lychnis diurna, . .	decreases	700	from	II.	to	IX.
Sagina subulata, . .	,,	1050	,,	I.	,,	X.
Stellaria media, . .	,,	950	,,	,,	,,	,,
S. holostea, . . .	,,	1200 ?	,,	II.	,,	,,
S. graminea, . . .	,,	850	,,	,,	,,	IX.
Cerastium triviale, . .	,,	1527	,,	I.	,,	X.
Hypericum pulchrum, .	,,	1340	,,	,,	,,	,,
H. androsæmum, . .	,,	680	,,	,,	,,	,,
Oxalis acetosella, . .	,,	950	,,	,,	,,	,,
Ulex galii, . . .	,,	600	,,	,,	,,	VII.

Sagina procumbens, and *Lotus corniculatus* are exceptions.

On page 522–26 :—

Vicia sepium, . . .	decreases	400	from	I.	to	X.
Spiræa ulmaria, . .	,,	2100	,,	,,	,,	,,
Alchemilla vulgaris, . .	,,	700	,,	,,	,,	,,
A. arvensis, . . .	,,	550	,,	,,	,,	,,
Pyrus aucuparia, . .	,,	650	,,	,,	,,	,,
Geum rivale, . . .	,,	2000	,,	,,	,,	,,
Epilobium montanum, .	,,	1100	,,	II.	,,	X.

Several exceptions occur here, as *Vicia sylvatica*, *Lathyrus macrorrhizus*. *Rubus saxatilis*, *Rosa canina*, *R. spinosissima*, *and Epilobium palustre*.

On page 526–28 :—

Sedum anglicum, . .	decreases	1800	from	I.	to	X.
Circæa lutetiana, . .	,,	400 ?	,,	II.	,,	,,
Chrysosplenium oppositifolium,	,,	850	,,	I.	,,	,,
Hydrocotyle vulgaris, .	,,	400	,,	II.	,,	,,
Angelica sylvestris, . .	,,	1450	,,	I.	,,	,,
Chærophyllum sylvestre, .	,,	1800	,,	II.	,,	,,
Hedera helix, . . .	,,	900	,,	,,	,,	,,
Lonicera periclymenum, .	,,	450	,,	,,	,,	,,
Asperula odorata, . .	,,	300 ?	,,	IV.	,,	,,

Bunium flexuosum appears to be exceptional, but it withers early, and may have escaped observation.

On page 528–30 :—

Galium palustre, . .	decreases	550	from	I.	to	X.
Valeriana officinalis, . .	,,	1250	,,	,,	,,	,,
Scabiosa succissa, . .	,,	850	,,	,,	,,	,,
Bellis perennis, . .	,,	1030	,,	,,	,,	,,
Achillea millefolium, .	,,	930	,,	,,	,,	IX.
Antennaria dioica, . .	,,	1100	,,	,,	,,	X.
Leontodon autumnalis, .	,,	1900	,,	,,	,,	,,
Crepis paludosa, . .	,,	950	,,	II.	,,	,,

The three common thistles are exceptional in their vertical distribution. The easily blown seeds render them independent in their locality.

On pages 532–34 :—

Jasione montana, . .	decreases	1670	from	I.	to	X.
Erica cinerea, . .	,,	530	,,	,,	,,	,,
E. tetralix, . . .	,,	150	,,	,,	,,	,,
Ilex aquifolium, . .	,,	650	,,	,,	,,	,,
Fraxinus excelsior, . .	,,	500	,.	V.	,,	,,
Myosotis repens, . .	,,	650	,,	II.	,,	,,
Pedicularis sylvatica, .	,,	550	,,	,,	,,	,,

Menyanthes trifoliata and *Pedicularis palustris* are the only non-conformists here and they are both marsh plants. It must be borne in mind that the Donegal summits are nearly 1000 feet lower than

those of Kerry, so that altitudes in the former of 2000 feet and upwards must be disregarded in this comparison. We cannot deal with plants as having a limit when they have actually reached the tops of the mountains.

On pages 534–36 :—

Digitalis purpurea, . .	decreases	650	from	I.	to	X.
Veronica chamædrys, .	,,	2000	,,	,,	,,	,,
V. agrestis, . . .	,,	800	,,	II.	,,	,,
V. serpyllifolia, . .	,,	1200	,,	I.	,,	,,
Rhinanthus crista-galli, .	,,	1080	,,	,,	,,	,,
Thymus serpyllum, . .	,,	1800	,,	,,	,,	,,
Ajuga reptans, . .	,,	800	,,	,,	,,	,,
Pinguicula vulgaris, . .	,,	800	,,	,,	,,	,,
Primula vulgaris, . .	,,	1000	,,	,,	,,	,,
Lysimachia nemorum, .	,,	250	,,	,,	,,	,,
Anagallis tenella, . .	,,	275	,,	,,	,,	,,
Plantago lanceolata, . .	,,	1530	,,	,,	,,	,,

Prunella vulgaris and three plaintains appear to be slightly exceptional.

On pages 538–40 :—

Euphorbia hyberna, . . .	decreases	900	from	I	to	XI.
Salix cinerea, . . .	,,	580	,,	,,	,,	X.
Betula alba, ...	,,	530	,,	,,	,,	,,
Orchis maculata, . .	,,	850	,,	,,	,,	,,

Several irregularities occur amongst the spurges and willows, but none are very noteworthy.

On pages 540–42 :—

Juncus conglomeratus, .	decreases	850	from	I.	to	X.
J. acutiflorus, . .	,,	500	,,	,,	,,	,,
Triglochin palustre, . .	,,	500	,,	II.	,,	,,
Eriocaulon septangulare, .	,,	600	,,	I.	,,	,,
Schænus nigricans, . .	,,	300	,,	,,	,,	,,

The Monocotyledonous species here are chiefly marsh plants, and do not conform to the general law.

On pages 542-44 :—

Eriophorum vaginatum. .	decreases	1300	from	I.	to	X.
Carex pulicaris, . .	,,	680	,,	,,	,,	,,
C. paniculata, . . .	,,	1500	,,	II.	,,	,,
C. ovalis, . . .	,,	300	,,	I.	,,	,,
C. limosa, . . .	,,	500	,,	,,	,,	,,
C. panicea, . . .	,,	1400	,,	,,	,,	,,
C. flava, ...	,,	850	,,	,,	,,	,,
C. hornschuchiana, . .	,,	1000	,,	,,	,,	,,
C. glauca, . . .	,,	650	,,	,,	,,	,,
C. binervis, . . .	,,	470	,,	,,	,,	,,
Agrostis alba, . . .	,,	650	,,	,,	,,	,,
Holcus lanatus, . .	,,	600	,,	,,	,,	,,
Aira cæspitosa, . .	,,	1000	,,	,,	,,	,,

The sedges afford better illustration than the grasses. The mountain distribution of some of the latter family is very vague.

On pages 546–48 :—

Molinia cærulea, . .	decreases	550	from	I.	to	X.
Poa pratensis, . . .	,,	1400	,,	,,	,,	,,
Dactylis glomerata, . .	,,	800	,,	,,	,,	,,
Brachypodium sylvaticum,	,,	500	,,	,,	,,	,,
Polypodium vulgare, .	,,	1700	,,	,,	,,	,,
Lastrea æmula, . .	,,	1300	,,	,,	,,	,,
Polystichum aculeatum, .	,,	1500	,,	,,	,,	,,
Asplenium adiantum-nigrum,	,,	400	,,	,,	,,	,,
A. trichomanes, . .	,,	1000	,,	,,	,,	,,
Athyrium filix-fœmina, .	,,	1050	,,	,,	,,	,,
Pteris aquilina, . .	,,	800	,,	,,	,,	,,
Trichomanes radicans, .	,,	750	,,	,,	,,	,,
Adiantum capillus-veneris,	,,	650	,,	,,	,,	,,
Scolopendrium vulgare, .	,,	900	,,	II.	,,	,,
Hymenophyllum tunbrigense,	,,	2000	,,	,,	,,	,,

The grasses here redeem their character, and most of the ferns agree with what might be predicated of their distribution fairly well.

On page 548 :—

Osmunda regalis, . .	decreases	300	from	II.	to	X.
Ophioglossum vulgatum, .	,,	600	,,	,,	,,	,,

Botrychium lunaria reaches an unusual height on the Derry trap-rocks, as do several other species.

The plants enumerated above are all those with an upward limit (*a*). Viewed with regard to their powers of existing on mountains all plants may be regarded as falling within one of five divisions. They have either :—

(*a*) An upward limit.
(*b*) A downward limit.
(*c*) An upward and a downward limit.
(*d*) No limit.
(*e*) No mountain existence.

The Irish flora consists of about 1000 species. 600 of these, therefore, fall under (*e*), and are excluded. In (*d*) we have those species which reach all summits (or very nearly so) in Ireland. These are :—

Potentilla tormentilla,
Galium saxatile,
Campanula rotundifolia,
Calluna vulgaris,
Melampyrum pratense,
Euphrasia officinalis,
Rumex acetosa,
R. acetosella,
Empetrum nigrum,
Juncus squarrosus,
Luzula sylvatica,
L. campestris,
Scirpus cæspitosus,
Carex stellulata,
C. pilulifera,
Anthoxanthum odoratum,
Agrostis vulgaris,
Aira flexuosa,
Festuca ovina,
Lastrea filix-mas,
L, dilatata,
Blechnum boreale,
Hymenophyllum unilaterale,
Lycopodium selago.

A few of these, as the two Carices, Anthoxanthum and the two Lastreas are somewhat doubtfully included here, as they require more moisture and shade than all summits can afford, and some of them seem to have upward limits in the northern counties. One or two others might perhaps be regarded as summit plants, as *Viola sylvatica* and *Cerastium triviale*.

With these also ought perhaps to be included some species of an aberrant distribution. These are sea-loving plants which find suitable conditions of atmospheric moisture repeated on the mountain top; *Armeria maritima*, *Sedum anglicum*, *Cochlearia officinalis*, and *Silene maritima*. In some cases, as on Slievemore in Achill (2200), *Armeria maritima* is continuous from the summit to the sea- washed base.

Amongst (*c*), plants with limits in both directions, the majority of Alpines occur. The following is a complete list of the so-called Alpine plants in Ireland.

Thalictrum alpinum,
Draba incana,
Arabis petræa,
Silene acaulis,
Dryas octopetala,
Epilobium alsinifolium,
Rubus chamæmorus,
Alchemilla alpina,
Sedum rhodiola,
Saxifraga stellaris,
S. nivalis,
S. aizoides,
S. oppositifolia,
Galium boreale.
Saussurea alpina,
Hieracium anglicum.
Arctostaphyllos uva-ursi,
Vaccinium vitis-idæa,
Polygonum viviparum,
Oxyria reniformis,
Salix herbacea,
Juniperus nana,
Carex rigida,
Sesleria cærulea,
Poa alpina,
Cryptogramme crispa,
Polystichum lonchitis,
Asplenium viride,
Lycopodium alpinum,
L. selaginoides,
Isoetes lacustris.

All of these have lower limits in some parts of Ireland at any rate. A few may be said to have no upper limit perhaps, and these are the only plants falling under (*b*), which is a needless division; they are *Saxifraga stellaris*, *Salix herbacea*, and *Carex rigida*. The remaining alpine species belong to (*c*), for although some may have no downward limit in some parts of Ireland, they are none the less bound by altitude and latitude combined. A plant which reaches sea level in Donegal (e. g. *Draba incana*) and does not descend to within 2000 feet of the sea in Kerry, has of course a lower limit within the Irish mountains.

Of the Alpine plants in Ireland the following alone never pass

below the limits of cultivation which may be taken at about 750 feet above sea-level.[1]

Thalictrum alpinum,
Arabis petræa,
Epilobium alsinifolium,
Rubus chamæmorus,
Alchemilla alpina,
Saxifraga nivalis,
Saussurea alpina,
Polygonum viviparum,
Carex rigida,
Polystichum lonchitis,
Lycopodium alpinum.

The following descend to about the verge of cultivation in a few places, but not to sea-level:—

Silene acaulis, . .	550,	Dunaff Head, Donegal.
Saxifraga stellaris, .	500,	Donegal.
Vaccinium vitis-idæa,	900,	Poisoned Glen, Donegal.
Oxyria reniformis, .	900,	Poisoned Glen, Donegal.
Salix herbacea, . .	800,	Innishowen, Donegal.
Cryptogramme crispa,	750,	Ardara, Donegal.
Asplenium viride, .	700,	Lough Esk, Donegal; Ben Bulben, Leitrim.

The following reach sea-level, or very near it, in Donegal, and some of them elsewhere:—

Draba incana; sea-level, or very near it, Sligo, Derry, Donegal.
Dryas octopetala; sea-level, Galway; 800, Derry.
Sedum rhodiola; sea-level, several counties.
Saxifraga aizoides; sea-level, Antrim; 650, Donegal.
S. oppositifolia; sea-level, Donegal.
Galium boreale; sea-level, several counties.
Hieracium anglicum; sea-level, several counties.
Arctostaphyllos uva-ursi; sea-level, several counties.
Juniperus nana; sea level, several counties.
Seslæria cærulea; sea-level, Clare, Galway, Donegal.
Lycopodium selaginoides; sea-level, several counties.
Isoetes lacustris; sea-level; several counties.

The distribution of the Alpine species is exhibited diagrammatically in the Table. The group being limited lends itself readily to such a means of illustration.

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[1] There are a few scattered instances of higher cultivation than 750 feet, chiefly in the north-east of Ireland, but they are quite exceptional.

It must be mentioned here that the numbers given as heights represent an enormous number of observations. Every species was made a special study on each mountain; and for fuller information the reader must refer to the various papers indicated on page 570.

I will now draw attention briefly to some points of comparison between Irish and British vertical distribution. The most interesting species found on the Irish mountains are those which do *not* occur elsewhere in the British Isles. These are:—

Arenaria ciliata, 1950 to 1200 feet on Ben Bulben, Sligo.

Saxifraga geum (including *S. hirsuta*) 2650 feet (Kerry and Cork) to sea-level.

S. umbrosa, 3370 feet to sea-level (Kerry and Cork); 2600 to 500 feet (Waterford); 2680 feet to sea-level (Galway); 2000 feet (to 800 feet Poisoned Glen), (Donegal).

Arbutus unedo, 520 feet to sea-level (Kerry).

Dabeocia polifolia, 1900 feet (Mayo and Galway), to sea-level.

Pinguicula grandiflora, 2250 feet to sea-level (Kerry and Cork).

Sea-level signifies one or two hundred feet to actual sea-level.

It will be seen that we have no truly Alpine species which is not found in Great Britain. On the contrary, our total number is a very small proportion (not a third) of those found east of the Irish Sea. Of this group the only interesting ones are a few which descend to a lower level in Ireland than they do even in Scotland. It is somewhat surprising that this should occur even in a single case when we reflect upon the fact that Scotland (including the islands) extends six degrees north of Ireland, and therefore, as a natural result, what are mountain species with us become lowland ones long before we reach the north of Scotland. Thus in Skye, *Alchemilla alpina* is about the commonest plant in some places right down to the sea; and close to the base of Ben Lawers we meet with *Polygonum viviparum*, *Rubus chamæmorus*, and other Alpines, which either do not occur at all in Ireland (e.g. *Vaccinium uliginosum*), or else only at considerable elevation. The poverty of Ireland in this respect is the more remarkable since the climate is well suited for many of these absentees, and their absence can only be accounted for by the simple geographical fact that they never reached us.

Nevertheless, as I have already observed, it is interesting to find some Scotch Alpine species less Alpine in Ireland; and it is to be remarked that the difference in latitude enhances this discrepancy. According to Watson's *Cybele Britannica*—

Saxifraga nivalis has 2100 feet for lower limit in Scotland. In Ireland it descends to 1950 feet in Sligo.

Salix herbacea has 1860 feet for its lower limit in Scotland (Dr. Dickie, however, reports it at 1600 feet in Orkneys). In Donegal it descends to 800 feet in one place in Innishowen, and abundantly to 1000 feet in Fanet and elswhere.

Silene acaulis and *Dryas octopetala* descend, the former to less than 600 feet above the sea in Donegal, and the latter to sea-level in Clare and Galway. These do not reach sea-level in Great Britain till we come to the Orkneys and Shetlands.

Saussurea alpina and *Carex rigida* both descend to 1000 feet in Donegal. We shall have to travel probably far north in Scotland before we meet them so far down the mountains. I have not been able to find out accurately in what part of Scotland this may occur, but not, I think, south of lat. 57°.

Thalictrum alpinum, *Arabis petræa*, *Draba incana*, *Saussurea alpina*, *Arctostaphyllos uva-ursi*, *Oxyria reniformis*, *Polygonum viviparum*, *Poa alpina*, *Polystichum lonchitis*, *Carex rigida*, and *Isoetes lacustris* find their most southern habitats in the British Islands in Ireland. With the exception of *Arabis petræa* and *Arctostaphyllos uva-ursi*, these occur in Kerry. Of the latter two, the first occurs in Tipperary, the latter in Clare.

This is of interest, since the Brecknock Beacon (2910 feet) in Wales is higher than any mountain in its latitude, or south of it, in Ireland. Brecknock Beacon is a little north of Hungry Hill (2248 ft.) in Cork, which is the most southern point containing any Alpines in Ireland. Of these *Carex rigida* and, I think, *Isoetes lacustris* are not found south of the Irish stations in Europe.

The late Mr. Watson, in his standard work, the *Cybele Britannica*, adopted two primary divisions, into which the plants of Great Britain, under the joint influence of latitude and elevation, arranged themselves. Each of these divisions he further subdivides into three zones. The primary divisions he names Arctic and agrarian, and the

secondary ones super-, mid-, and infer-Arctic and agrarian zones respectively. Each of these zones is characterized by the presence and absence of certain species; or, in other words, one set of plants find their upper limits in each zone and ascend no higher from below, while another set find their lower limits in the same zone, and descend no lower. Briefly, he characterizes the zones thus:—

6. Super-Arctic zone, . .	*Salix herbacea*, without *Calluna*.
5. Mid-Arctic zone, . . .	*Calluna vulgaris*, without *Erica*.
4. Infer-Arctic zone, . . .	*Erica tetralis*, without *Pteris*.
3. Super-agrarian zone, . .	*Pteris aquilina*, without *Rhamnus*.
2. Mid-agrarian zone, . .	*Rhamnus catharticus*, without *Clematis*.
1. Infer-agrarian zone, . .	*Clematis*, *Rubia*, *Cyperus longus*.

This formula will be found at page 492 of his fourth volume; but a little farther on he gives a fuller series of illustrations of each zone. There the reader will find that the lower limit of the super-Arctic zone is evidenced by the cessation of six species which are all high Alpines that do not occur at all in Ireland. And also, in accordance with the test plants adduced above, it would appear that this zone does not exist in Ireland. No mountains are high enough to escape from Calluna in Ireland, excepting, perhaps, a small space (300 feet) of the highest point of MacGillycuddy's Reeks. Its absence there is, however, probably due to insufficient soil to nurture the roots, and stunted barren plants were found within a hundred feet of the summit. At that latitude, were circumstances favourable, Calluna would probably range at least 3500 feet.

Similarly, the lowest zone (infer-agrarian) is characterized by its holding within its bounds a certain group of plants which can ascend no higher. Of these, eight typical ones are quoted: three of these only occur in Ireland. In fact, this whole group contains about two hundred species (exclusive of Rubi) and hardly a tenth of these are native in Ireland. This zone is mainly represented in the south and south-east of England, as the uppermost one is in the north of Scotland, and on the summits of its highest mountains. The plants of Ireland ought to fall, therefore, within Watson's four intermediate zones. The species dealt with in my table may be distributed amongst the mid-Arctic, infer-Arctic, and super-agrarian zones; while the remainder of the Irish plants not there treated of should belong to the mid-agrarian. It will be found, however, that there are several

species which range in Great Britain throughout the three agrarian zones, and yet do not occur in my list of Irish mountain plants. Those which fulfil these conditions will be found to be chiefly species which under no circumstances ascend mountains. In many cases they are maritime. Such plants should all, however, occur in the north and north-east of Ireland, which corresponds in the lowland parts to Watson's super-agrarian zone, while the lowland parts of southern and south-western Ireland will fall under the mid-agrarian. The difference in these two zones is about three degrees of latitude, or a thousand feet of elevation.

Certain exceptional southern and western species which occur in the extreme south-western and western parts of Ireland tend to prove that the climate there verges upon that of Watson's infer-agrarian zone in Great Britain; but the species are few and hardly sufficiently prevalent to stamp their character upon the whole flora of the limited areas in which they occur.

Let us see now how far the above deductions are borne out by the facts of the case. I have already stated that out of about two hundred species characteristic of Watson's lowest zone (infra-agrarian) in Britain, and not extending above it, hardly a tenth occur in Ireland as native plants. Those which do are:—

Matthiola sinuata: south-east.
Helianthemum guttatum (var. *Breweri*): south-west.
Viola curtisii: coasts of all Ireland; maritime; distribution misunderstood in Watson's time. (?)
Elatine hydropiper: north-east; hardly representative of the group. It occurs on the Continent in Norway and Sweden, and like other aquatics is considerably independent of climate.
Geranium rotundifolium: south-west.
Trifolium subterraneum: south-east.
T. glomeratum: south-east.
Myriophyllum verticillatum: throughout Ireland, but aquatic, and therefore not so dependent on climate.
Rubia peregrina: southern half of Ireland.
Diotis maritima: south of Ireland.
Erica ciliaris: west.
Cicendia filiformis: south-west.
Sibthorpia europæa: south-west.

Orobanche hederæ: widely spread, but not occurring in the north-eastern counties. A couple of Donegal stations are the only exceptions to its distribution in the southern half of Ireland. The western climate of Ireland is very equable from south to north, owing to the influence of the Gulf Stream branches. Thus the Killarney fern, *Bartsia viscosa*, *Carum verticillatum*, all reappear in Donegal.

Euphorbia Peplis: south.

Asparagus officinalis: south-east.

Juncus acutus: south and south-east.

Rhyncospora fusca: south and west.

Carex divisa: east (on the median line).

C. punctata: south-west.

Glyceria borreri: east (on the median line).

We will next consider those Irish species which occur in Great Britain in Watson's infer-agrarian and mid-agrarian zones only. We may expect to find a larger number of these; and, theoretically, we should find here the bulk of the Irish flora, which does not anywhere ascend the mountains as high as from six or seven hundred to a thousand feet. We should find all those lowland southern species which do not reach the North of Ireland, and also some species which may be called maritime in their distribution, since they find perennial mildness of climate close by the sea, or else require the actual influence of a saline atmosphere. The Irish species occurring in these two zones only are:—

Thalictrum flavum: chiefly southern; very rare in the north of Ireland generally, and not occurring in Donegal.

Ranunculus parviflorus: south (and east? on the median line).

Papaver hybridum: south, east, and north-east. A weed of cultivation. (?)

Glaucium luteum: chiefly south; rare in the north, and not occurring in Donegal, though maritime.

Crambe maritima: maritime, and found, but very rarely, in the north: extinct except in the west.

Nasturtium sylvestre: south and south-midland.

N. amphibium: chiefly southern, but occurs in the larger water systems throughout, though not in the extreme north. Barely reaches Donegal.

Raphanus maritimus: maritime, and occurs, but rarely, round the coast.

Viola hirta: east and west (on the median line).

Sagina apetala: throughout Ireland; exceptional; not common in the north.

Stellaria glauca: chiefly midland; not found in the north.

Linum angustifolium: south-west, south, and south-east to the median line.

Malva moschata: native only in south and south-midland of Ireland.

Lavatera arborea: maritime and doubtfully native, excepting, perhaps, Dublin and Galway, on the median line (Howth and Arran).

Erodium maritimum: southern and south-eastern chiefly, but reaches north-east, being maritime.

Geranium columbinum: southern and south-eastern to the median line; extending sparingly also to the north-east?

Euonymus europæus: chiefly southern, but extends, with limestone, to the north at Loughs Neagh and Erne. Just reaches Donegal.

Rhamnus catharticus and *R. frangula:* following somewhat similar laws as the last, but much rarer, especially *R. frangula*. Neither occur in the extreme northern county, Donegal.

Ulex nanus: typical *U. nanus* ("*U. eu-nanus*") is not found in Ireland. The form which does occur is *U. gallii*, and it is not prevalent in the north, and not found in Donegal. In Britain this form is much more widely spread than the type.

Trifolium scabrum: south, south-east, and east.

T. fragiferum: south-west, south, south-east, and east.

Rosa systyla: south-west.

R. arvensis: quite rare north of the median line; common in the south.

Epilobium hirsutum: commonest in middle and south; rare in west and extreme north. Rather exceptional, but quite aquatic.

Cornus sanguinea: west and north-west. Follows the limestone, like *Rhamnus* and *Euonymus*. Very rare, however.

Apium graveolens: brackish marshes; much commoner southwards, but hard to decide where native.

Cicuta virosa: commonest northwards. An aquatic and exceptional, but very rare, and not reaching Donegal.

Sium latifolium: as under last.

S. angustifolium: aquatic, and widely but thinly distributed; rare in the north.

Helosciadium nodiflorum: aquatic and common, but local in Donegal.

Pimpinella magna: south-west and west.

Œnanthe lachenalii: brackish aquatic; scarce in the north.

Œ. phellandrium: common in the south and parts of midland northern counties. An aquatic which does not reach Donegal.

Crithmum maritimum: round the coast, but commoner in the south than the north; exceptional.

Torilis nodosa: south, south-east and east; very rare, and probably introduced in the north.

Asperula cynanchica: south-west and west.

Dipsacus sylvestris: southern half of Ireland; often doubtfully native.

Helminthia echioides: south and east.

Thrincia hirta: chiefly in the south; very rare in the north.

Carduus tenuiflorus: chiefly in the south and east; barely reaches Donegal.

C. pratensis: commonest northwards and westwards. A bog species, with an unexpected range in Ireland, and ascending mountains in the north and west to a considerable height above the agrarian zone.

Bidens tripartita: aquatic, and found sparingly all over Ireland.

Artemisia maritima: east (on the median line only).

Erigeron acris: southern half of Ireland.

Senecio viscosus and *S. erucæfolius:* east (on the median line only).

Inula crithmoides: south and south-east along the coast to the middle of Ireland.

Pulicaria dysenterica: a marsh species common in the east and south; rare in the north-west and north.

Anthemis nobilis: south to north; distribution difficult to ascertain. Long in use and easily established by peasants' dwellings and roadsides.

A. cotula: southern half of Ireland chiefly; very rare as native in the north.

Campanula trachelium: south.

Ligustrum vulgare: south and east, on sea-cliffs.

Erythræa pulchella: south and east.

Chlora perfoliata: chiefly in the south of Ireland, and not found in the north.

Convolvulus soldanella: maritime; very rare on the northern coasts.

Veronica polita: throughout Ireland; a weed of cultivation, and rare in the extreme north.

Bartsia viscosa: south-western, with an outlying north-western station in Donegal.

Linaria elatine: south and west.

L. minor: south and east; appears to be spreading northwards.

L. repens: south, east, and north; very sparingly.

Lathræa squamaria: chiefly in the middle counties, but found from south to north.

Verbena officinalis: southern half of Ireland, but only common in south and south-west; one outlying station in the north.

Salvia verbenaca: south and north-east to the median line.

Mentha pulegium: chiefly in the south-west and north-east.

Calamintha officinalis: south-west and west, extending sparingly to north-west.

Teucrium scordium: south-west.

Ballota nigra: chiefly in the east, but found north and south; often doubtfully indigenous.

Lamium galeobdolon: south-east and east.

Myosotis palustris and *Symphytum officinale:* both found in watery places, and becoming scarce northwards. *Symphytum officinale* is often introduced.

Cynoglossum officinale: maritime; south to north-east.

Statice bahusiensis and *S. occidentalis:* maritime; both very scarce in the north.

Chenopodium murale and *C. rubrum:* south, south-east, and east. The latter is found in the north-east.

Atriplex portulacoides and *A. littoralis:* maritime; confined, or nearly so, to the south-east and east.

Polygonum minus: throughout, but commoner southwards?

Rumex maritimus: south-east and east.

Euphorbia paralias: southern half of Ireland; very rare in the north-east.

E. portlandica: maritime, like the last; commonest on east and south-east coasts, but occurs in extreme north.

E. exigua: very scarce, and perhaps introduced northwards.

Spiranthes autumnalis: southern half of Ireland.

Cephalanthera ensifolia: south, west, and north of Ireland.

Orchis pyramidalis: chiefly midland, but found in extreme north and south on seaside sandhills.

O. morio: south-east, east, and middle.

Ophrys apifera: southern half of Ireland.

Iris fœtidissima: east (on the median line); possibly not native.

Allium vineale: south to east, with a couple of outlying stations on the north-east, and one in Donegal.

Colchicum autumnale: south-east and middle.

Hydrocharis morsus-ranæ: middle and north-east; aquatic.

Sagittaria sagittifolia: middle and north-east; aquatic.

Butomus umbellatus: southern half and north-east; aquatic.

Potamogeton pectinatus and *P. gramineus:* commonest in the south, but found in extreme north; aquatic.

Zostera nana: east and perhaps north; marine.

Arum maculatum: rare northwards, but follows limestone.

Lemna trisulca: not found in Donegal, and chiefly in east; aquatic.

L. polyrrhiza: middle of Ireland; aquatic.

L. gibba: middle and north-east; aquatic.

Typha angustifolia: east and north; aquatic.

Juncus obtusiflorus: scattered thinly near coast, but not in extreme north.

Scirpus savii: aquatic; chiefly, like the last, near the coast; round Ireland.

Carex divulsa: south to east.

C. axillaris: east (on the middle line).

C. stricta: throughout; aquatic.

C. strigosa: middle, east, and north of Ireland; exceptional.

Avena flavescens: middle and south; very rare northwards.

Glyceria distans: south, east, north-east, and north; marine.

G. procumbens: south and east.

G. loliacea: round Ireland; a coast species.

Festuca uniglumis: east and north-east; a coast species.

Bromus erectus: southern half of Ireland, with a single northern station; sometimes doubtfully indigenous.

Hordeum sylvaticum: east.

H. pratense and *H. murinum:* south and east, with a single northern station.

Lepturus incurvatus: maritime; round Ireland, but commonest on east and south-east coast.

Polystichum angulare: throughout; exceptional.

Lastrea thelypteris: marshy; chiefly southern, but with a few stations in the north.

Asplenium lanceolatum: south.

Adiantum capillus-veneris: west and north, on the coast; exceptional.

Equisetum telmateia: throughout, but less common in the west and north.

It will be seen that the above list is fully in accordance with the views already stated. It is necessary to mention here, however, that an additional view of the distribution of plants in Great Britain has been adopted by Mr. Watson. In this view he takes into account only the geographical areas which certain sets of species occupy within the kingdom, and omits the consideration of their vertical range on the mountains. But it is of course impossible to make two satisfactory codes of distribution, especially as the one already described is partly dependent on latitude and therefore coincides largely with his more purely geographical division. This latter gives also six types, and is, in nomenclature at anyrate, somewhat more convenient. We have (1) British, or spread throughout; (2) English, chiefly in south or south-middle Britain; (3) Scottish, north or north-middle Britain; (4) Highland, chiefly about the mountains; (5) Germanic, chiefly in East England; (6) Atlantic, chiefly in West England.

These types do not suit the distribution of Irish plants. In the first place *Germanic* is almost totally unrepresented. *Atlantic* is in Ireland a misnomer, as most of them occur round the coast, and the group reaches a maximum in Ireland on the south-east side, not on the west. Again *British* is unsatisfactory because it includes species so differing in range as *Potentilla tormentilla,* which grows everywhere even to the top of the highest mountains, as well in Scotland as in Ireland, and *Fumaria capreolata,* which never leaves the lowlands. And the continental distribution of such species renders this discrepancy still more glaring. Keeping in view as much as possible the methods adopted by Mr. Watson, the Irish flora might be subdivided as follows:—

I. *Ubiquitous.* In all parts of Ireland, and reaching tops of highest mountains or nearly so.

LIST OF PAPERS, BY THE AUTHOR,

FROM WHICH ALTITUDES HAVE BEEN TAKEN.

"Flora of North-Western Donegal."—*Journal of Botany*, 1879-80.

"Notes on Irish Plants."—*Journal of Botany*, June, 1881.

"Rare Plants in Donegal."—*Journal of Botany*, August, 1881.

"On the Botany of the Galtee Mountains."—*R. I. Acad. Proc.*, ser. II *Science*, vol. iii.

"Notes on Mountain Plants in Kerry."—*Journal of Botany*, June, 188

"Flora of Croaghgorm Range, Co. Donegal."—*Journal of Botany*, 188

"On the Botany of the Mac Gillicuddy's Reeks."—*R. I. Acad. Pro* ser. II., *Science*, vol. iii., 1882.

"Flora of Innishowen, Co. Donegal."—*Journal of Botany*, 1883.

"On the Flora of the Mayo and Galway Mountains."—*Proc. R.* *Acad.*, ser. II., *Science*, vol. iii.

"On the Plants of Some of the Mountain Ranges of Ireland."—*Pro* *R. I. Acad.*, ser. II., *Science*, vol. iv. (January, 1885).

"Flora of South-West Donegal."—*Proc. R. I. Acad.*, ser. II., *Scien* vol. iv. (July, 1885).

"Further Report on above."—*Tom. cit.* (July, 1886).

"On the Botany of the Valley of the Suir."—*Scient. Proc. Roy. Du* *Soc.*, N. S., vol. iv., p. 326 (1885).

XLVI.

A CATALOGUE OF BINARY STARS FOR WHICH ORBITS HAVE BEEN COMPUTED. WITH NOTES. BY J. E. GORE, M.R.I.A., F.R.A.S., Honorary Member of the Liverpool Astronomical Society.

[Read June 9, 1890.]

THE following list (Tables A to H) of the elements of binary star orbits has been compiled from various sources, and includes all the orbits I have been able to find. A few orbits may possibly have been missed, but the number of such omissions must, I think, be small.

The stars are arranged in order of Right Ascension, and the elements computed for each, in order of length of period, commencing with the shortest found.

Column 1 contains a number referring to the notes (*vide* pp. 575–599).

Column 2, the star's designation, Σ denoting the eminent Russian astronomer, F. G. W. Struve, and OΣ his equally eminent son, Otto Struve.

Columns 3 and 4 give the Right Ascension and Declination of the binary stars reduced to the epoch 1890·0. I have computed these positions from the Greenwich ten-year Catalogue for 1880 for all the binaries contained in that Catalogue. The positions of the fainter stars, and of the southern binaries, are only approximate, but will be found sufficiently close to identify the object.

Column 5 contains the period in years, the + sign denoting that the *apparent* orbital motion is direct, or in the direction of *in*creasing position angles, and the - sign that the position angle is *de*creasing.

Column 6 gives the computed epoch of periastron passage.

Column 7, the eccentricity (e) of the *real* ellipse described by the companion round the primary star, supposed to be at rest.

Column 8, the inclination, i or γ, of the real orbit to the plane of projection, which is a plane at right angles to the line of sight, or a tangent plane to the star sphere at the place of the star.

Column 9 gives the position angle, Ω, of the line of nodes, reckoning from the zero of position angles.

Column 10 gives the value of λ, the angle which the line from the principal star to the periastron makes with the line of nodes, measured on the real orbit.

Column 11 contains the value of a, the semi-axis major of the real ellipse, measured in seconds of arc.

Column 12 gives the name of the computer of the elements given.

Column 13, the estimated magnitudes of the component stars. These are chiefly taken from Struve's estimations.

Column 14, the colours of the components.

Column 15 gives the spectrum of the star's light, observed as a single star. The numbers given refer to Secchi's types of stellar spectra. It will be seen that the observed spectra are of types I. and II. only. No undoubted binary star has yet been found with a spectrum of types III. or IV., types so characteristic of the red and variable stars.

Column 16 contains the "hypothetical parallax," which I have computed for each orbit from the formula $p = aP^{-\frac{2}{3}}$. This formula rests on the assumption that the combined mass of the components of the binary star is equal to the mass of the sun.

Column 17 gives the most recent parallax found by actual observation for those binaries which have been measured for parallax.

Columns 18 and 19 contain the values of the constants A and B, computed from Mr. A. A. Rambaut's formulæ (*Monthly Notices*, R. A. S. March, 1890). With the aid of these quantities, the value of π V at any time may be calculated, π being the star's parallax in seconds of arc, and V the relative orbital velocity in the line of sight in miles per second. If V can be determined with the spectroscope, then the value of π can be immediately deduced. The maximum value which V can attain is equal to $\pm$ A + B, and occurs when the star is passing through the line of nodes, the position angle of which is given in Column 9. Mr. Rambaut's formulæ are as follows:—

$$\pi \mathrm{V} = \frac{la^2 \sin \gamma}{Pb} \left[e \cos \lambda + \cos (\theta - \lambda) \right]$$

or

$$\pi V = A + B \cos (\theta - \lambda),$$

where

$$A = \frac{lae \sin \gamma \cos \lambda}{P\sqrt{1 - e^2}}$$

and

$$B = \frac{la \sin \gamma}{P\sqrt{1 - e^2}},$$

where l = mean motion of the earth in miles per second, and θ the true anomaly at any time.

In Column 20 I have given the relative brilliancy of each binary star (on the assumption that all the stars in question are spheres of equal density) computed in accordance with Mr. Monck's formula ("*Observatory,*" Feb. 1887), viz. :—

$$\frac{k_1}{k_2} = \left(\frac{I_1}{I_2}\right)\left(\frac{P_1}{P_2}\right)^{\frac{4}{3}}\left(\frac{a_2}{a_1}\right)^2,$$

where k represents the brilliancy per *unit of surface* (on the above-mentioned assumption), I, the intensity of the light, as measured by the photometer, P, the period of the star's revolution, and a, the angular radius (semi-axis major) of the orbit.

Adopting Mr. Monck's standard star ($k = 1$), viz. ξ Ursæ majoris, with Dunér's orbit, and the Oxford determination of its magnitude, this formula for any other binary star becomes

$$k = 10^{0{\cdot}4(3{\cdot}75 - m)}\left(\frac{P}{60{\cdot}79}\right)^{\frac{4}{3}}\left(\frac{2{\cdot}549}{a}\right)^2,$$

where m is the magnitude of the star according to the Oxford measures (*Uranometria Nova Oxoniensis*), P being expressed in years and a in seconds of arc.

This formula is strictly correct only if the mass of the smaller star of the pair may be neglected; but in the extreme case of equality in the masses of the components the effect will only be to reduce k to $\frac{k}{\sqrt[3]{2}}$ or $\frac{k}{1{\cdot}2599}$.

For the fainter binaries (which have not yet been measured with the photometer) I have adopted the magnitudes of Argelander's *Durchmusterung*, or those given by Struve, and for the southern binaries, the estimates of the *Uranometria Argentina.* In the case of ζ Sagittarii I have taken the magnitude as given in the Harvard *Photometry.*

Column 21 contains a reference to the publications in which the given elements of the orbit orginally appeared.

The position angle and distance of a binary pair at any time t may be computed from the elements of the orbit by means of the

following formulæ :—

$$(1) \qquad u - \epsilon \sin u = \mu\,(t - T).$$

$$(2) \qquad \tan \tfrac{1}{2} v = \sqrt{\frac{1+e}{1-}} \tan \tfrac{1}{2} u.$$

$$(3) \qquad \tan(\theta_t - \Omega) = \cos i \tan(v + \lambda).$$

$$(4) \qquad \rho = a\,(1 - e \cos u)\,\frac{\cos(v+\lambda)}{\cos(\theta_t - \Omega)},$$

where ϵ is the eccentricity expressed in degrees $= 57^\circ{\cdot}296 \times e$; μ is the mean annual motion $= \dfrac{360^\circ}{P}$; u the eccentric anomaly, and v the true anomaly for the epoch t; θ_t the required position angle, and ρ the distance.

The Notes give details respecting the probable value of the different orbits, the masses of the binary stars, when the parallax is known, &c. Some recent measures of each object are also given, which may be of use to computers who may wish to recalculate the orbit of any particular binary.

My best thanks are due to Messrs. Monck and Rambaut for valuable assistance and advice.

16. Hypothetical parallax $p = a P^{-\frac{1}{3}}$.	17. Observed parallax π.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
"	"				
..	..	..	..	..	A, N., 2277.
0·057	..	− 0·002	0·135	..	Ast. Nach., 2156.
0·065	..	..	..	..	—
0·056	..	− 0·008	0·124	0·68	A. N., 1636.
0·036	..	..	..	..	—
0·02	..	+ 0·009	0·073	1·48	—
0·34	+ 0·154, Struve.	..	..	0·33	—
0·323	+ 0·3743,	..	..	..	M. N., R. A. S., vol. xxi., p. 66.
0·256	Schweizer and Socoloff.	− 0·469	0·782	..	A. N., 2111.
0·255	..	− 0·338	0·806	0·51	A. N., 2091.
0·018	..	− 0·008	0·020	9·77	—
0·031	..	− 0·035	0·070	6·23	A. N., 2052.
0·16	..	+ 0·145	0·456	..	A. N., 2148.
0·171	..	..	..	..	M. N., x., 171.
0·128	..	..	..	..	M. N., xliii., 264.
0·154	..	− 0·121	0·359	0·21	M. N., xlviii., No. 1.
0·049	..	+ 0·075	0·228	1·17	M. N., l., No. 2.
0·223	0·166, Gill. 0·323, Hall.	+ 0·105	0·781	0·0015	M. N., xlvi., No. 5.
0·037	..	+ 0·012	0·086	4·09	M. N., xlvii., No. 2.
0·028	..	+ 0·031	0·069	1·07	—
0·026	..	− 0·001	0·046	14·01	A. N., 2802.
0·684	0·193, Gyldèn.	− 1·629	3·788	..	—
..	..	..	..	..	—
..	0·43, Belopolsky and Wagner.	..	..	..	—
0·616	0·370, Gill.	..	..	..	—
0·623	0·407, Elkin.	..	..	5·31	—

e is something peculiar about the spectrum.

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	16. Hypothetical parallax $p = aP^{-\frac{2}{3}}$.	17. Observed parallax π.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
	″					
	..	..	..	..	..	—
	..	..	..	..	..	—
	0·569	..	− 0·788	2·439	6·35	M.N., xlix. No. 8.
	0·03	..	+ 0·010	0·269	1·83	—
	0·185	0·198 (Rad. obs.)	..	..	..	A. N. 452.
	0·202	..	..	..	..	Mem., R. A. S., vol. v. p. 200.
	0·134	..	..	..	11·72	Sidereal Messenger, Nov., 1890.
	0·088	..	..	..	..	Untersuchungen über die Fixstern-System, 1847, [p. 233.
	0·085	..	.	..	..	A. N., 551.
	0·083	..	..	..	..	Mem. R. A. S., xvi. 321.
	0·067	..	..	..	..	—
	0·075	..	+ 0·014	0·100	..	A. N., 1227.
	0·074	..	+ 0·015	0·102	38·12	A. N., 2168.
l.	0·082	..	..	..	..	A. N., 967.
	0·060	..	..	..	..	M. N., xxxi., p. 195.
	0·059	..	..	..	..	—
	0·068	..	..	..	..	A. N., 967.
	0·056	..	..	..	2·90	—
	0·058	..	− 0·031	0·093	..	A. N., 2322.
	0·055	..	− 0·010	0·076	..	—
	0·058	..	..	..	..	C. R., lxxix., p. 1467.
	0·064	..	− 0·079	0·353	0·21	A. N., 2156.
	0·060	..	..	..	..	—
	0·060	..	..	..	..	—
	0·063	..	− 0·072	0·365	0·21	A. N., 2808.
l.	0·045	..	..	..	..	—
	..	..	..	..	..	A. N., 2078.
	0·038	..	− 0·044	0·158	..	A. N., 2095, and Trans. R.I.A., xxvi., Pt. IV.
	0·036	..	..	..	4·06	—

16. Hypothetical parallax $p = a P^{-1}$.	17. Observed parallax π.	18. A.	19. B.	20. Relative brightness. $\frac{k_1}{k_2}$.	21. Remarks.
"					
0·035	..	..	..	..	—
0·026	..	..	..	..	A. N., 990.
0·040	..	..	..	..	—
0·035	..	..	..	..	A. N., 1127.
0·022	..	+ 0·029	0·119	21·26	A. N., 2417.
0·032	..	..	..	2·08	A. N., 2998.
..	..	..	..	..	—
0·036	..	..	..	..	A. N., 2049.
0·036	..	– 0·066	0·090	92·99	—
0·256	0·04, Klinkerfues.	..	..	..	—
0·17	..	..	..	..	Proc. R.I.A., June, 1872.
0·167	..	..	..	..	M.N., xxxiii., 101.
..	..	..	..	..	M. A. S., v., p. 209.
0·164	..	– 0·163	0·706	1·00	—
0·166	..	– 0·172	0·720	..	—
0·181	..	..	..	..	M. A. S., xvi., p. 322.
0·147	..	..	..	..	—
0·155	..	..	..	..	—
0·156	..	..	..	..	A. N., 680.
0·154	..	..	..	..	—
0·121	..	+ 0·009	0·078	1·80	Proc. R. I. A., 2nd Ser., vol. iv., No. 5 (Science).
0·047	..	..	..	..	A. N., 2294.
0·051	..	– 0·084	0·224	2·11	,, ,,
0·134	..	..	..	..	—
..	..	..	..	..	—
..	..	..	..	..	"Cycle of Celestial Objects."
0·123	..	..	..	..	—
0·129	..	..	..	..	Cycle, etc., p. 356.
0·124	..	..	..	..	—

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.	16. Hypothetical parallax $p = a P^{-\frac{2}{3}}$.	17. Observed parallax π.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
	"					
	..	..	..	..	..	—
	..	..	..	..	..	M. N., xi., p. 136.
	..	..	..	..	..	—
	0·108	..	..	..	..	C. R., lxxxviii., 1198.
	0·133	..	..	..	..	Cycle continued, p. 451.
	..	..	..	..	..	—
	0·135	..	..	..	..	M. A. S., xviii., p. 67. *Cf.* M. A. S., vi., 149.
	..	..	..	..	..	M. N., xiii., p. 258.
	0·122	..	+ 0·109	0·513	4·92	..
	..	..	..	..	..	M. A. S., vol. v., p. 193.
	0·075	..	− 0·041	0·538	2·46	M. N., xxxv., p. 370.
	0·048	..	− 0·045	0·100	..	M. N., xlvii., No. 8.
	0·048	..	− 0·063	0·131	0·37	A. N., 2438.
	0·046	..	..	..	..	M. N., xlvii., No. 1.
	0·042	..	..	..	..	A. N., 2415.
	..	..	− 0·030	0·099	7·28	A. N., 2345.
	..	..	..	..	..	A. N., 2156.
	0·03	..	+ 0·015	0·051	0·95	A. N., 2421.
1	1·682	0·913, Henderson.	..	..	..	—
	0·964	0·880, Moesta.	+ 1·426	4·814	1·31	M. N., xliv., 238. Elkin' orbit corrected.
	1·119	0·521, ,,	..	..	..	M. N., xxx., p. 192.
	0·856	0·76, Gill.	..	..	..	M. A. S., xvii., p. 88.
	0·963	0·676, Elkin.	+ 1·462	4·827	..	—
	1·129	..	..	..	..	—
	0·725	..	..	..	..	—
	1·674	..	..	..	..	—
	1·127	..	..	..	..	M. N., xxxvii., p. 97.
	0·959	..	+ 1·674	4·684	0·77	
	0·929	..	..	..	..	—

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16. Hypothetical parallax $p = a P^{-1}$.	17. Observed parallax π.	18. A.	19. B.	20. Relative brightness. $\frac{k_1}{k_2}$.	21. Remarks.
″ 0·524	..	..	..	..	M., R. A. S., vi., 149.
0·192	..	− 0·198	0·600	0·34	A. N., 2129.
..	..	..	..	..	A. N., 2118.
0·20	..	..	..	..	—
0·19	..	..	..	..	—
0·325	..	..	..	..	M. N., xxxii., p. 250.
0·097	..	..	..	..	—
0·075	..	+ 0·207	0·292	2·07	A. N., 2064.
0·084	..	..	..	..	Cat. des Étoilés Doubles et Multiples: C. Flam., p. 88.
0·076	..	− 0·74	0·355	1·40	A. N., 2338.
0·068	..	− 0·069	0·323	1·72	A. N., 1868.
0·068	..	..	..	..	—
0·074	..	..	..	..	—
0·083	..	..	..	..	—
0·077	..	..	..	..	—
0·088	..	..	..	..	—
0·096	..	..	..	..	—
0·066	..	..	..	..	M. A. S., vi., 156.
0·067	..	..	..	..	—
0·072	..	..	..	..	A. N., 868.
0·047	..	..	..	..	—
0·036	..	..	..	..	—
..	..	..	..	..	—
..	..	..	..	..	M. N., xxxiii., 460.
0·025	..	+ 0·022	0·051	2·74	Oxford Obs., No. 1, p. 64.
0·034	..	..	..	..	A. N., 2194.
0·034	..	+ 0·050	0·085	1·53	A. N., 2026.
0·038	..	..	..	..	M. N., xxxii., p. 250.
0·059	..	+ 0·175	0·324	0·45	A. N., 2843.

lenotes that there is something peculiar about the spectrum.

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m.	16. Hypothetical parallax $p = a P^{-\frac{2}{3}}$.	17. Observed parallax ϖ.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
	″ 0·052	..	+ 0·105	0·226	0·58	A. N., 2280.
	0·048	..	..	..	0·82	A. N., 2531.
pin,	0·032	..	..	..	22·10	A. N., 2904.
lines,	0·035	..	..	..	..	Bulletin Ast., July, 1888. and A. N., 2121.
	0·033	..	− 0·030	0·144	20·83	A. N., 2123.
.koly.	0·130	..	..	..	..	A. N., 1199.
	0·060	..	0·000	0·227	5·70	A. N., 2121.
	0·057	..	..	..	..	—
pin.	0·080	..	..	..	..	M. N., xv., 180.
	0·076	..	..	..	..	M. N., xv., 91.
	0·084	..	..	..	..	M. A. S., v., 205.
	0·042	..	..	..	..	A. N., 990.
	0·063	..	..	..	..	—
	0·054	..	..	..	..	—
	0·063	..	..	..	..	A. N., 551.
	0·067	..	..	..	..	A. N., 2037.
	0·065	..	+ 0·022	0·103	1·77	Trans. R. I. A., xxv., p. 584, and A. N., 2103.
	0·042	..	..	..	..	—
	0·040	..	..	..	..	A. N., 668.
	0·032	..	..	..	..	—
	..	..	..	..	..	A. N., 2126.
	0·030	..	− 0·017	0·038	28·16	A. N., 2106.
	0·029	..	− 0·020	0·052	29·54	M. N., xlviii., 254.
	0·124	..	..	..	..	—
	0·119	..	..	..	..	—
	0·116	..	..	..	..	A. N., 1868.
	0·121	..	− 0·073	0·533	..	A. N., 2332.
	0·127	..	− 0·083	0·572	4·67	—
	..	..	..	..	..	—

…continued.

16. …tical parallax …= $P\Delta$.	17. *Observed parallax* π.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
	″				
0·121	..	..	..	..	M. N., xxxi., 195.
0·122	..	..	..	..	C. R., xxxviii., p. 871.
...	...	..	..	..	M. N., xiii., p. 258.
0·004	..	−0·021	0·053	0·43	A. N., 2928.
0·053	..	−0·054	0·266	..	A. N., 2438.
0·036	..	..	..	1·74	A. N., 2623.
0·045	..	0·000	0·000	4·21	A. N., 2582.
0·079	..	+0·055	0·409	0·88	—
0·104	..	−0·126	0·455	0·013	A. N., 2287.
0·107	..	−0·112	0·526	..	—
0·096	...	−0·066	0·447	0·014	A. N., 2949.
0·041	..	..	..	..	—
...	..	..	..	..	M. N., ix., p. 145.
...	..	..	..	..	A. N., 2037.
0·033	..	+0·045	0·092	7·35	A. N., 2041.
0·246	0·169, Krüger.	..	..	..	—
0·301	0·162 „	..	..	..	B. J., 1832, s. 295.
0·235	..	..	..	..	Mem. R. A. S., v. p. 217.
0·231	..	..	..	..	—
0·237	..	..	..	..	—
0·222	..	−0·450	0·926	0·30	M. N., xlviii., No. 5.
..	..	..	..	..	Sidereal Messenger. Nov. 1890.
..	..	..	..	..	M. N., ix., p. 145.
0·243	..	..	..	..	C. R., xxxii., p. 51.
0·238	..	..	..	..	C. R. lxxix, 1248.
..	..	..	..	..	A. N., 1681.
0·227	..	..	..	..	A. N., 1682.
0·231	..	−0·370	0·899	0·29	Oxford Obs., 1, 63.
0·255	..	..	..	..	A. N., 444.
0·225	..	..	..	..	A. N., 1135.

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…m.	16. Hypothetical parallax $p = aP^{-\frac{2}{3}}$.	17. Observed parallax ϖ.	18. A.	19. B.	20. Relative brightness $\frac{k_1}{k_2}$.	21. Remarks.
	0·210″	..	..	..	..	M. N., xv., 42, 44.
	0·08	..	..	..	1·134	M. N., Nov. 1890.
	0·075	..	− 0·009	0·455	23·04	M. N., xlvi., No. 8.
…c.[1]	..	..	− 0·183	1·039	..	A. N., 2073.
	0·168	..	..	..	..	Schiaparelli's orbit corrected, M. N., xliii., 368.
	..	..	..	..	..	—
	0·100	..	..	..	..	M. N., xlvi., No. 3.
	0·099	..	− 0·086	0·318	1·22	M. N., l., No. 5.
	0·117	..	..	..	..	M. N., xv., p. 208.
pin.	0·057	..	..	..	..	Mem. R.A.S., xvi., p. 293.
lines.	0·073	..	..	..	..	A. N., 1517.
	0·045	..	− 0·027	0·082	31·29	M. N., l.
	0·01	..	− 0·017	0·066	37·94	A. N., 1561.
	0·023	..	− 0·001	0·063	2·46	—
'	0·019	..	+ 0·025	0·052	3·07	M. N., xlvii., No. 6.
gel.	0·07	..	− 0·040	0·556	6·85	A. N., 2824.
	0·062	..	..	..	8·49	A. N., 2602.
	0·052	..	..	..	..	Proc. R.I.A., 2nd series, vol. iv., No. 5 (Science).
	0·03	..	− 0·058	0·128	11·01	—
	0·028	..	..	..	3·64	—
	0·400	..	..	..	..	Sidereal Messenger, Nov. 1890.
c.	0·469	0·468, Ball. 0·430, Glasenapp.	+ 0·017	1·204	..	A. N., 2709.
	0·347	0·270, Hall.	+ 0·016	0·635	0·07	,,
	0·286	0·432, Pritchard.	..	..	..	—
Vogel.	0·08	..	+ 0·037	0·660	2·12	A. N., 2771.
	0·091	..	− 0·096	0·306	4·28	A. N., 2749.
ogel.	0·056	..	− 0·038	0·083	..	A. N., 2050.
	0·055	..	− 0·032	0·077	9·21	—
o.	0·032	..	− 0·012	0·077	11·07	—
	·121	0·054, Brunnow.	+ 0·036	0·791	..	—

…thing peculiar about the spectrum.

NOTES.

1. Struve, 3062. One revolution has now been nearly completed since it was discovered in 1782 by Sir William Herschel, who measured it, 1782·65 : 319°·4. Schur's period of 112·644 years seems to be near the truth. Some recent measures are:—

1882·83 :	308°·14 :	1″·52, Doberck.
1883·60 :	309 ·83 :	1 ·69, Engelmann.
1887·104 :	310 ·73 :	1 ·50, Tarrant (A.N. 2899).
1889·57 :	321 ·1 :	1 ·45, Burnham (A.N. 2957).

A list of measures by Dr. Doberck, from 1876 to 1882, will be found in the *Transactions* of the Royal Irish Academy, vol. xxix., part XIII. (1890).

2. O. Struve, 4. A binary star discovered by O. Struve in 1844. From that year to 1887 the companion had described about 77° of its apparent orbit, the motion being retrograde, or in the order of decreasing position angles. An orbit was computed by Professor Glasenapp in 1889. The greatest difference between the observed and computed position angles ($\theta_o - \theta_c$) is + 19°·4 at the epoch 1874·71 (Dembowski). The computed distances do not agree very well with the earlier measures. Professor Glasenapp says, "Dans une quinzaine d'années on pourrait entreprendre une révision des observations afin d'obtenir une orbite plus exacte; jusqu' à ce temps là ce travail serait peut-être prématuré."

Some recent measures are:—

1880·57 :	163°·00 :	0″·44, Burnham.
1887·93 :	141 ·10 :	(0 ·30), H. Struve.

The latter measure was made with the 30-inch refractor of the Poulkova Observatory.

3. η Cassiopeiæ. This well-known binary star has described about 116° of its apparent orbit since its discovery by Sir W. Herschel in 1779, the distance diminishing from about 11″ to 4¾″. Dr. Doberck's orbit is perhaps the best hitherto computed. Sadler thinks that Dunér's value of a "is much too large," and that it probably does not exceed 8″·5. Assuming Struve's parallax of 0″·154, the combined mass of the components is from 5¼ to 10¾ times the mass of the sun varying

according to the period we assume. Schweizer's parallax of 0″·3743 combined with Doberck's elements gives a mass of only 0·0366 that of the sun.

Some recent measures are :—

1882·76	:	166°·28	:	5″·13,	Doberck.
1882·87	:	165 ·70	:	5 ·155,	Engelmann.
1886·974	:	178 ·64	:	4 ·71,	Tarrant (*A.N.*, 2866).

4. O. Struve 20 = 66 Piscium. This binary star has described an arc of about 70° of its apparent orbit since its discovery by O. Struve in 1843, the distance diminishing from about 0″·66 to 0″·35. An orbit was computed by Prof. Glasenapp in 1889. The observations are fairly well represented, considering the difficulty of measuring so close a pair. Glasenapp says, "L'étoile 66 Piscium présente un objet très difficile à observer; il est à désirer que ceux qui possèdent des instruments puissants l'observent annuellement."

Some recent measures are :—

1883·84	:	2°·9	:	0″·40,	Perrotin.
1884·850	:	357 ·75	:	0 ·525,	,,
1886·80	:	349 ·30	:	(0 ·45),	H. Struve.
1887·910	:	352 ·00	:	0 ·42,	Tarrant (*A.N.*, 2899).
1887·93	:	351 ·10	:	(0 ·40),	H. Struve.
1888·78	:	350 ·70	:	(0 ·42),	,,

5. B 36, Andromedæ = Σ 73. This binary has described about 60° of its apparent orbit since its discovery by Struve in 1830. The distance has slightly increased. Variation in light was suspected by Schmidt.

Some recent measures are :—

1882·69	:	359°·90	:	1″·24,	Doberck.
1882·81	:	2 ·65	:	—	,,
1882·81	:	0 ·75	:	—	,,
1882·82	:	3 ·80	:	1 ·32,	,,
1882·93	:	3 ·06	:	1 ·40,	,,
1885·28	:	2 ·0	:	1 ·35,	Perrotin.
1888·05	:	7 ·7	:	1 ·18,	Schiaparelli.

A list of measures by Dr. Doberck from 1876 to 1882 will be found in the *Transactions* of the Royal Irish Academy, vol. xxix, part xiii. (1890).

6. *p* Eridani. About 120° of the apparent orbit has been described between 1825 and 1888, the distance increasing from about 2″·1 to 6″·8. The period found by Doberck seems certainly too small. My orbit represents all the measures satisfactorily, and Dunlop's in 1825 within – 5°·5. The following are some recent measures :—

1886·901	:	229°·9	:	6″·63,	Pollock.
1886·909	:	230 ·8	:	6 ·85,	,,
1887·121	:	232 ·3	:	6 ·89,	Tebbutt.
1887·131	:	231 ·4	:	6 ·90,	,,
1887·734	:	230 ·7	:	—	,,
1887·747	:	229 ·5	:	6 ·91,	,,
1887·934	:	228 ·5	:	7 ·27,	,,
1888·038	:	228 ·1	:	6 ·66,	,,

7. Struve 228. An arc o about 130° of the apparent orbit has been described between 1829 and 1889. My orbit represents all the measures fairly well for so close a pair, the greatest difference $(\theta_o - \theta_c)$ being + 11·27 at the epoch 1888·142 when it was measured 33·60 by Schiaparelli. This measure, however, does not agree with Schiaparelli's later measures.

Some recent measures are :—

1888·931	:	25°·73	:	0″·36,	Schiaparelli.
1889·018	:	30 ·25	:	0 ·35,	,,
1889·021	:	34 ·56	:	0 ·41,	Young.
1889·570	:	26 ·97	:	0 ·37,	Tarrant.
1890·09	:	41 ·03	:	0 ·42,	,,

According to my orbit " the distance between the components will gradually increase during the next few years, up to a maximum of about 0″·55, and then diminish again as the companion approaches the periastron. The minimum distance will not be reached till the position angle is nearly 180° (after the periastron passage), when the components will probably be separated by less than 0″·2." (*Monthly Notices*, R. A. S., Dec. 1889.)

8. 40 Eridani (BC). This is the double 9th magnitude companion to the 4·5 magnitude star 40(O^2) Eridani. Recent measures show that my orbit will require revision. A physical connexion possibly exists between the binary pair and O^2 Eridani, as both have a common proper motion (4″·07 per annum in the direction of positive angle 212°·4). The angular motion, however, if any, is very slow. The distance is

about 82″. The following are some recent measures of the binary pair:—

1886·924 :	111°·03 :	3″·01, Tarrant.
1888·84 :	106 ·8 :	2 ·94, Burnham.

9. 14(i) Orionis = O. Struve, 98. About 60° of the apparent orbit had been described up to 1889. My elements represent all the measures fairly well, the greatest difference, $\theta_o - \theta_c$ being + 5°·05 at the epoch 1865·98. According to this orbit "the distance will remain nearly constant (about 1″) during the next fifty years, the angle diminishing to about 107° in the year 1936." (*Monthly Notices*, R.A.S., March, 1887.) The following are some recent measures:—

1886·988 :	196°·26 :	1″·15, Tarrant (*A.N.*, 2866).
1887·025 :	196 ·1 :	0 ·95, Young.
1887·117 :	195 ·56 :	0 ·94, Schiaparelli.
1888·097 :	193 ·32 :	0 ·952, ,,
1888·90 :	193 ·4 :	0 ·98, Leavenworth.

10. O. Struve, 149. About 92° of the apparent orbit has been described since its discovery by O. Struve in 1843, the distance increasing from about 0″·48 to 0″·72. The elements given in the Catalogue were published by Prof. Glasenapp in 1889, and represent the measures fairly well. Some recent measures are:—

1888·21 :	296°·50 :	0″·83, Schiaparelli.
1883·17 :	289 ·8 :	0 ·74, Engelmann.
1884·20 :	292 ·55 :	0 ·93, ,,

11. 12 Lyncis (AB) = Struve, 948. This is the close pair of a fine triple star discovered by Sir W. Herschel in 1780. The arc described up to 1887 is about 55°. My elements represent all the measures fairly well, the greatest residual ($\theta_o - \theta_c$) being + 4°·70 at the epoch 1866·31. Some recent measures are:—

1881·28 :	129°·5 :	1″·55, Jedrzcjewicz.
1882·76 :	128 ·4 :	1 ·704, Engelmann.
1887·325 :	126 ·32 :	1 ·56, Tarrant (*A.N.*, 2898).

The three stars are now nearly in a straight line. Tarrant measured AC as follows:—

1887·325 : 306°·62 : 8″·62,

which shows little, if any, change since Sir W. Herschel's measure—

1782·34 : 302°·5 : 9″·38.

12. Sirius. The faint companion to this brilliant star was discovered by Alvan Clark in 1862. The position angle was then about 85°. This was reduced to about 0° at the end of 1889, the distance having diminished from about 10″ to 5½″. Recent measures show that the period of about 50 years is too small. My period of 58·47 years is probably nearer the truth. The elements computed by me represent all the measures closely, the greatest difference $\theta_o - \theta_c$ being + 5°·95 at the epoch 1869·10, when the position angle was measured 74·76 by Brünnow. But the angle was measured 71°·67 by Engelmann, 1868·26, and this agrees much better with the other measures before and after that epoch. The following are some recent measures:—

1886·144	:	28°·67	:	7″·21,	Hough.
1886·22	:	28 ·66	:	7 ·32,	Washington Obs.
1887·14	:	25 ·36		7 ·08,	Young.
1887·195	:	23 ·66	:	6 ·78,	Hough.
1887·238	:	24 ·14	:	6 ·508,	Hall.
1888·97	:	13 ·85	:	5 ·27,	Burnham.
1890·27	:	359 ·7	:	4 ·19,	,, (*private letter*).

Observing with the 36-inch refractor of the Lick Observatory, Burnham says: "The companion to Sirius is a very easy object, under proper conditions, and is not likely to ever get beyond the reach of the large refractor. I have carefully looked for other stars near Sirius, but without finding anything worth noting."

Assuming a parallax of 0″·40, my elements give the sum of the masses of Sirius and its companion = 2·886 times the sun's mass, with a mean distance of 21·45 times the sun's mean distance from the earth.

I find that the plane of the orbit is at right angles to the plane of the Milky Way.

13. Struve, 1037. The elements given by Mädler seem very doubtful. The orbit is a hypothetical one, based on the supposition that one of the components is a close double—a hypothesis which has not yet been verified by telescopic observation. Some recent measures of the known pair are:—

1880·22	:	312°·05	:	1″·33,	Doberck.
1880·23	:	320 ·93	:	—	,,
1884·18	:	310 ·6	:	1 ·23,	Perrotin.
1887·184	:	310 ·9	:	1 ·26,	Tarrant.

The star was measured by Struve.

1827·28 : 337°·8 : 1″·24,

so that the distance seems nearly constant.

14. α Geminorum (Castor) = Σ 1110. The change of position angle since 1719 has been about 125°. Sadler thinks that "a good orbit for Castor has yet to be computed." Some recent measures are as follows:—

1882·82	:	234°·35	:	5″·69,	Doberck.
1882·88	:	234 ·29	:	5 ·559,	Perrotin.
1883·03	:	232 ·28	:	5 ·44,	Doberck.
1884·17	:	232 ·15	:	5 ·840,	,,
1885·110	:	232 ·93	:	5 ·78,	Tarrant (*A.N.*, 2866.)
1885·15	:	232 ·2	:	5 ·74,	Engelmann.
1885·99	:	231 ·15	:	·36,	Doberck.
1886·00	:	232 ·93	:	5 ·83,	,,
1886·33	:	232 ·2	:	5 ·75,	Engelmann.
1888·28	:	230 ·9	:	5 ·85,	Schiaparelli.
1889·09	:	229 ·6	:	5 ·68,	Leavenworth.

A long list of measures by Dr. Doberck from 1875 till 1886 will be found in the "*Transactions* of the Royal Irish Academy," vol, xxix., part XIII. (1890).

Using Johnson's parallax of 0·1984″, I find the sum of the mass of the components of Castor only 0·052398 of the mass of the sun, a result which would imply that the component stars are gaseous bodies! Johnson's parallax is, however, of doubtful value.

15. ξ Cancri (AB) = Struve, 1196. Seeliger's orbit (1888) is probably the best. Nearly two revolutions have now been completed since its discovery by Sir W. Herschel in 1781. All three stars form probably a physically connected system, but the motion of C round AB is slow. Professor Seeliger has recently investigated the motion of this system, and has come to the conclusion that to make the observations agree with theory it is necessary to assume that the third star C is in reality a very close double, of which the components revolve round their centre of gravity in about 17·6 years, and both round the centre of gravity of the components of the close pair. This supposed duplicity of C has not yet been detected with the telescope. Burnham in 1889, using a power of 1500, failed to see any other component. The following are some recent measures:—

A B.

1884·17	:	62°·85	:	0″·985, Perrotin.
1884·28	:	67 ·0	:	0 .94, Engelmann.
1885·29	:	59 ·4	:	1 ·05, ,,
1886·08	:	57 ·18	:	1 ·09, Tarrant.
1886·30	:	56 ·4	:	1 ·08, Engelmann.
1888·27	:	43 ·7	:	1 ·04, Schiaparelli.
1889·19	:	40 ·3	:	1 ·05, Leavenworth

½ (A + B) and C.

1882·26	:	130°·0	:	5″·46, Schiaparelli.
1885·29	:	126 ·8	:	5 ·44, Engelmann.
1886·080	:	125 ·71	:	5 ·48, Tarrant.
1886·30	:	127 ·2	:	5 ·35, Engelmann.

AC.

1889·18	:	119°·3	:	5″·65, Leavenworth.

BC.

1889·19	:	128°·5	:	5″·43, ,,

16. Struve, 3121. More than a revolution has been completed since its discovery by Struve in 1830. Celoria's orbit is, perhaps, the best. The object is, however, close and difficult to measure; and some of the recorded measures are very discordant.

Some recent measures are:—

1882·25	:	194°·8	:	0″·305, Engelmann.
1882·31	:	205 ·84	:	0 ·45, Schiaparelli.
1883·22	:	221 ·2	:	0 ·387, Engelmann.

17. ω Leonis = Struve, 1356. Doberck's second orbit is probably the best. A complete revolution has nearly been described since its discovery by Sir W. Herschel in 1781.

Some recent measures are:—

1885·17	:	93°·30	:	— Doberck.
1885·27	:	90 ·6	:	0″·72, Engelmann.
1885·307	:	93 ·96	:	0 ·69, Tarrant.
1886·32	:	92 ·2	:	0 ·73, Engelmann.
1888·27	:	98 ·5	:	0 ·68, Schiaparelli.
1888·57	:	95 ·8	:	0 ·71, Leavenworth.

Measures by Dr. Doberck, from 1876 to 1885, will be found in the *Transactions* of the Royal Irish Academy, vol. xxix., part xiii. (1890).

18. ϕ Ursæ Majoris = O Σ 208. A close and difficult double star discovered by O. Struve in 1843.

19. γ Leonis = Σ 1424. An arc of only about 33° has been described since its discovery by Sir W. Herschel in 1782. The orbit is, therefore, somewhat uncertain, and likely to remain so for many years to come.

Some recent measures are :—

1882·24	:	114°·33	:	3″·521,	Engelmann.
1882·28	:	113 ·25	:	3 ·56,	Doberck.
1883·27	:	112 ·66	:	3 ·344,	Engelmann.
1884·19	:	113 ·30	:	3 .463,	Perrotin.
1885·12	:	113 ·0	:	3 ·45,	,,
1885·175	:	112 ·37	:	3 ·49,	Doberck.
1885·307	:	115 ·39	:	3 ·34,	Tarrant.
1885·99	:	113 ·87	:	—	Doberck.
1888·35	:	114 ·0	:	3 ·36,	Schiaparelli.

A list of measures by Dr. Doberck, from 1876 to 1882, will be found in the *Transactions* of the Royal Irish Academy, vol. xxix., part XIII. (1890).

20. ξ Ursæ Majoris = Σ 1523. This was the first binary star for which an orbit was computed (by Savary in 1830). More than a complete revolution has now been completed since its discovery by Sir W. Herschel in 1780. The period has, therefore, been well determined, and seems to be about 60 years.

Some recent measures are as follows :—

1881·23	:	270°·35	:	1″·84,	Doberck.
1882·25	:	262 ·10	:	1 ·987,	Engelmann.
1882·25	:	259 ·43	:	2 ·00,	Doberck.
1883·32	:	257 ·83	:	2 ·002,	,,
1884·28	:	248 ·02	:	1 ·687,	Perrotin.
1884·41	:	249 ·60	:	1 ·920,	Engelmann.
1885·36	:	245 ·2	:	2 ·12,	,,
1885·414	:	243 ·36	:	1 ·87,	Tarrant.
1886·36	:	237 ·4	:	2 ·06,	Engelmann.
1888·29	:	222 ·7	:	1 ·64,	Schiaparelli.

A list of measures by Dr. Doberck, from 1875 to 1882, will be found in the *Transactions* of the Royal Irish Academy, vol. xxix., part XIII. (1890).

21. O. Struve, 234. Owing to the discordant measures of this very close and difficult double star my orbit is somewhat uncertain; but I think the period found is not far from the truth.

A recent measure is

1886·36 : 324° : 0″·20, Engelmann.

22. O. Struve, 235. An arc of over 100° has been described since its discovery in 1844.

Some recent measures are:—

1880·36	:	65°·57	:	0″·97,	Doberck.
1881·24	:	65 ·39	:	—	„
1882·27	:	69 ·65	:	—	„
1882·28	:	65 ·20	:	0 ·97,	„
1884·10	:	64 ·6	:	1 ·07,	Engelmann.

The companion is now moving round the aphelion end of the orbit, and the angular motion is therefore slow.

23. γ Virginis = Σ 1670. This famous binary star has been frequently measured and its orbit computed, but none of the orbits seem altogether satisfactory. Perhaps Thiele's period of 185 years is nearest the truth.

Some recent measures are as follows:—

1883·07	:	155°·59	:	5″·222,	Engelmann.
1884·38	:	155 ·73	:	5 ·427,	Perrotin.
1884·89	:	336 ·1	:	5 ·32,	Engelmann.
1885·382	:	156 ·77	:	5 ·35,	Tarrant.
1886·00	:	157 ·27	:	5 ·73,	Doberck.
1886·36	:	333 ·2	:	5 ·34,	By photography at Paris Observatory.
1887·41	:	334 ·2	:	5 ·43,	Schiaparelli.
1888·91	:	153 ·8	:	5 ·50,	Leavenworth (10 nights).
1889·31	:	153 ·4	:	5 ·72,	Burnham (36-inch refractor).

As the companion is now moving towards the aphelion end of the apparent eclipse the angular motion is of course diminishing and the distance increasing.

The components have been suspected of alternate variability in light, and the recorded position angles, occasionally differing by 180°, seem to confirm this suspicion. O. Struve found a variation of about 0·7 magnitude.

24. 42 Comæ Berenices = Σ 1728. A binary star in which the plane of the orbit passes through, or nearly through, the earth. The chief apparent change is therefore in the distance, the position angle varying but little except by 180°.

Some recent measures are :—

1881·25	:	190°·89	:	0″·61,	Doberck.
1882·93	:	192 ·11	:	0 ·560,	Engelmann.
1887·43	:	193 ·1	:	0 ·39,	Schiaparelli.
1889·085	:	9 ·6	:	0 ·55,	Leavenworth.

25. Struve, 1757. Casey's period of 401 years and mine of 340·38 years do not represent recent measures well. My second orbit (276·92 years) represents all the position angles from 1825 to 1887 fairly well.

Some recent measures are :—

1887·213	:	72°·44	:	2″·62,	Tarrant.
1887·356	:	72 ·75	:	2 ·79,	Young.
1887·425	:	72 ·22	:	2 ·377,	Schiaparelli.
1888·59	:	72 ·0	:	2 ·46,	Leavenworth.

26. 25 Canum Venaticorum = Σ 1768. A close, and for some years (1850–1880) a very difficult pair to measure.

Some recent measures are :—

1885·37	:	329°·1	:	0″·89,	Perrotin.
1885·539	:	149 ·63	:	0 ·77,	Tarrant (*A. N.*, 2866).
1887·46	:	142 ·7	:	0 ·72,	Schiaparelli.

27. Struve, 1819. Struve thought that this star was a binary pair, but Berberich has shown (*Ast. Nach.*, 2518) that all the measures may be satisfactorily represented on the assumption of uniform rectilinear motion. Some recent measures are :—

1882·27	:	16°·35	:	1″·39,	Doberck.
1882·28	:	13 ·58	:	1 ·16,	,,
1882·34	:	18 ·80	:	—	,,
1882·45	:	17 ·6	:	1 ·60,	Schiaparelli.
1885·41	:	11 ·5	:	1 ·39,	Perrotin.
1887·347	:	194 ·92	:	1 ·28,	Tarrant (*A. N.*, 2898).
1887·432	:	10 ·05	:	1 ·327,	Schiaparelli.

As the components are nearly equal in brightness, 180° should be deducted from Tarrant's measure.

28. α Centauri. This well-known binary is also the nearest of all the fixed stars to the earth, as far as is known at present. Although carefully measured for many years, its orbit is still somewhat doubtful. While Downing and Elkin make the period 76 or 77 years, Powell maintains that a longer period of about 87 years is more probable (*Mon. Notices*, Nov., 1884). A few years more should decide the question. Downing's elements combined with Gill's parallax of 0″·76 gives a mass of 2·0406 that of the sun. Some recent measures are:—

1884·194	:	199°·0	:	11″·96,	Russell.
1884·433	:	199 ·5	:	12 ·32,	„

From measures of $\Delta\alpha$ and $\Delta\delta$.

		E. of Meridian.			W. of Meridian.			
1885·527	:	198°·6	:	13″·47.	201°·7	:	14″·03,	Tebbutt.
1885·571	:	199 ·8	:	14 ·40.	202 ·0	:	14 ·17,	„
1885·582	:	200 ·8	:	14 ·08.	201 ·2	:	14 ·17,	„
1885·590	:	201 ·1	:	—	201 ·2	:	—	

1886·449	:	200°·80	:	14″·97,	Russell.
1886·487	:	202 ·46	:	15 ·05,	Pollock.
1886·548	:	201 ·02	:	14 ·87,	„

From measures of $\Delta\alpha$ and $\Delta\delta$.

29. ξ Boötis = Σ 1888. A double star, discovered by Sir W. Herschel, April 9, 1780; but he did not measure the position angle till 1782, when he found it about 24° (as now reckoned). Since that year the companion has described about 130° of the apparent orbit. Dr. Doberck's orbit is probably the best. Some recent measures are:—

1881·245	:	274°·85	:	4″·03,	Doberck.
1882·33	:	272 ·13	:	4 ·03,	„
1884·45	:	266 ·6	:	3 ·65,	Engelmann.
1885·366	:	264 ·29	:	3 ·44,	Tarrant (*A. N.*, 2866).
1885·55	:	263 ·1	:	3 ·61,	Engelmann.
1886·60	:	259 ·4	:	3 ·32,	„
1887·50	:	257 ·0	:	3 ·01,	Schiaparelli.
1888·621	:	253 ·87	:	3 ·52,	Maw.

(*Observatory*, March, 1889).

30. 44 (i) Boötis = Σ 1909. Doberck's orbit is probably the best. As the inclination of the orbit plane is high, the position angle

does not change much, except by 180°. Some recent measures are:—

1880·48	:	239°·35	:	4″·79,	Doberck.
1880·65	:	239 ·65	:	4 ·89,	,,
1883·35	:	240 ·9	:	5 ·02,	Engelmann.
1885·51	:	239 ·4	:	4 ·86,	By photography at Paris.
1885·62	:	241 ·1	:	5 ·00,	Jedrzejewicz.
1887·402	:	241 ·55	:	5 ·00,	Tarrant (*A. N.*, 2898).

I find that the plane of Doberck's orbit is at right angles to the plane of the Milky Way.

31. η Coronæ Borealis = Σ 1937. Some forty years ago it seemed uncertain whether the period of this binary was 43 or 66 years; but now that one revolution has been completed, the question has been decided in favour of the shorter period. Dr. Doberck's orbit is perhaps the best. Some recent measures are:—

1881·26	:	121°·27	:	—,	Doberck.
1882·30	:	134 ·81	:	0″·56,	,,
1882·50	:	135 ·4	:	0 ·59,	Schiaparelli.
1882·61	:	153 ·17	:	0 ·558,	Engelmann.
1883·51	:	153 ·16	:	0 ·510,	,,
1884·52	:	163 ·15	:	0 ·642,	Perrotin.
1884·64	:	165 ·64	:	0 ·578,	Engelmann.
1885·58	:	170 ·0	:	0 ·61,	,,
1886·508	:	178 ·56	:	0 ·63,	Tarrant (*A. N.*, 2866).
1886·64	:	179 ·5	:	0 ·57,	Engelmann.
1887·51	:	185 ·6	:	0 ·60,	Schiaparelli.
1887·630	:	185 ·98	:	0 ·72,	Tarrant (*A. N.*, 2898).

32. μ^2 Boötis = Σ 1938. This is the small star near the 4½ magnitude μ Boötis. The duplicity of μ^2 was discovered by Sir W. Herschel in 1781. The change in position angle since 1782 amounts to about 250°. The following are some recent measures:—

1882·27	:	123°·77	:	0″·75,	Doberck.
1882·52	:	120 ·4	:	0 ·80,	Schiaparelli.
1885·492	:	110 ·07	:	0 ·79,	Tarrant (*A. N.*, 2866).
1885·63	:	116 ·9	:	0 ·85,	Engelmann.
1886·78	:	106 ·2	.	0 ·70,	Jedrzejewicz.

There seems to be a physical connection between μ' and μ^2, as all 3 stars have a common proper motion.

33. O. Struve, 298. None of the orbits given seem quite satisfactory. Some of the recorded measures are, however, very discordant. Some recent measures are:—

1881·42	:	350°·3	:	0″·36,	Burnham.
1882·47	:	7 ·5	:	0 ·33,	Schiaparelli.
1883·517	:	22 ·42	:	0 ·31,	,,
1883·65	:	36 ·7	:	0 ·17,	Engelmann.
1884·44	:	49 ·0	:	0 ·30,	Perrotin.
1884·507	:	57 ·34	:	0 ·31,	Schiaparelli.
1885·65	:	60 ·9	:	0 ·27,	Engelmann.
1886·68	:	104 ·9	:	0 ·29,	,,
1886·668	:	133 ·68	:	0 ·33,	Schiaparelli.
1887·558	:	142 ·97	:	0 ·33,	,,

34. γ Coronæ Borealis = Σ 1967. A close and difficult double star. As in the case of 42 Comæ Berenices, the plane of the orbit nearly passes through the earth.

Burnham found, with 18½-inch refractor:—

1879·468, "No certain elongation; splendid night";
1880·482, "Single with V."; "Good night";
1880·559, ,,

and adds, "I found it single with the Madison 15½-inch on two nights 1881·47."

I do not know of any more recent measures.

I find that the plane of the orbit is at right angles to the plane of the Milky Way.

35. ξ Scorpii = Σ 1998. A complete revolution has been performed since its discovery by Sir W. Herschel in 1780. Dr. Doberck's elements are the best. The apparent orbit is a very elongated ellipse, owing to its high inclination, but the real orbit seems to be nearly circular. The more distant companion probably forms with the binary a ternary system.

Some recent measures are:—

A B.

1880·40	:	189°·69	:	1″·17,	Doberck.
1881·24	:	191 ·25	:	1 ·03,	,,
1882·27	:	193 ·65	:	1 ·19,	,,
1886·513	:	198 ·12	:	1 ·28,	Tarrant (*A. N.*, 2866).
1888·50	:	20 ·4	:	1 ·24,	Leavenworth.

B C.

½(A + B) and C,	1882°·36 :	68°·52 :	7″·63, Doberck.
„ „ „	1886 ·513 :	65 ·83 :	7 ·14, Tarrant (*A.N.*, 2866).
B C,	1888 ·50 :	68 ·0 :	7 ·14, Leavenworth.

Sir W. Herschel measured ½ (A + B) and C :—

1782·36 : 88°·6 : 6″·38,

from which it appears that the motion is very slow. All three stars have a common proper motion, and probably from one system.

36. σ Coronæ Borealis = Σ 2032. Dr. Doberck's second orbit is probably the best. About 220° of the apparent orbit has been described since its discovery by Sir W. Herschel in 1781; but the companion is now receding from the periastron, and the angular motion will in future years become very slow.

Some recent measures are as follows :—

1881·26 :	203°.99 :	3″·68, Doberck.
1883·26 :	205 ·4 :	3 ·77, Engelmann.
1885·74 :	207 ·3 :	4 ·09, „
1886·487 :	208 ·04 :	4 ·01, Tarrant (*A. N.*, 2866).

37. λ Ophiuchi = Σ 2055. Glasenapp's orbit is probably the best. Some recent measures are :—

1881·235 :	36°·07 :	1″·40, Doberck.
1882·41 :	38 ·44 :	1 ·36, „
1884·64 :	42 ·7 :	1 ·59, Engelmann.
1885·527 :	42 ·79 :	1 ·68, Tarrant (*A.N.*, 2866).
1885·63 :	42 ·6 :	1 ·64, Engelmann.
1886·66 :	44 ·1 :	1 ·57, „
1888·37 :	42 ·6 :	1 ·55, Leavenworth.

38. ζ Herculis = Σ 2084. Three complete revolutions of this remarkable binary have now been described since its discovery by Sir W. Herschel in 1782. Dr. Doberck's second orbit is perhaps the best.

Some recent measures are :—

1880·41	118°·37	1″·29, Doberck.
1881·235	112 ·90	1 ·43, ,,
1882·47	104 ·29	1 ·67, ,,
1882·76	106 ·97	1 ·754, Perrotin.
1883·72	102 ·52	1 ·650, ,,
1884·55	94 ·13	1 ·470, ,,
1884·71	98 ·77	1 ·890, ,,
1885·520	89 ·36	1 ·70, Tarrant (*A.N.*, 2866).
1886·75	89 ·9	1 ·78, Engelmann.
1887·65	79 ·4	1 ·55, Leavenworth.

39. Struve 2091[2] = Dembowski 15. A small binary star near Struve 2091, discovered by Dembowski in 1869. About 87° of the apparent orbit has been described. My orbit represents all the measures satisfactorily, both in angle and distance.

Some recent measures are :—

1882·5	99°·92	0″·48, Schiaparelli.
1883·735	88 ·80	0 ·42, ,,
1886·668	55 ·86	0 ·35, ,,
1887·566	45 ·36	0 ·30, ,,

This object will become much easier to measure in future years.

40. Struve 2107. An arc of about 64° of the apparent orbit was described between the years 1829 and 1875.

Some recent measures are :—

1882·51	234°·0	0″·50, Schiaparelli.
1885·57	236 ·1	0 ·78, Engelmann.
1887·51	244 ·6	0 ·47, Schiaparelli.

41. μ Draconis = Σ 2130. An arc of about 60° of the apparent orbit has been described since 1802. According to Berberich, the plane of the orbit is at right angles to the line of sight; and this is perhaps the only case in which we see the real orbit of a binary star.

Some recent measures are :—

1880·38	168°·37	2″·73, Doberck.
1880·60	166 ·88	2 ·56, ,,
1886·73	161 ·9	2 ·51, Engelmann.
1886·942	160 ·00	2 ·35, Tarrant (*A.N.*, 2866).

42. Struve 2173 = 221 B Ophiuchi. A complete revolution has been described since its discovery by Struve in 1829. Dunér's orbit seems to be a good one. It represents recent measures satisfactorily. Some of these are as follows :—

1882·58	109°·9	0″·31, Schiaparelli.
1885·66	21 ·9	0 ·30, Engelmann.
1887·401	350 ·47	0 ·46, Tarrant (*A.N.*, 2898).
1887·56	348 ·5	0 ·54, Schiaparelli.
1888·49	167 ·8	0 ·68, Leavenworth.

The components are nearly equal in brightness, so that Leavenworth's angle requires a correction of 180.° Variable light was suspected by O. Struve, and Leavenworth's measure seems to favour this supposition.

43. μ' Herculis. This is the fainter component of the wide double star μ Herculis = Σ 2220. The duplicity was detected by Alvan Clark in 1856.

Some recent measures are :—

1880·47	245°·9	0″·96, Burnham.
1881·41	252 ·1	0 ·92, ,,
1889·51	357 ·9	0 ·55, ,,

44. τ Ophiuchi = Σ 2262. An arc of about 285° of the apparent orbit has been described since its discovery by Sir W. Herschel in 1783, but the motion has been round the periastron of the orbit. The angular motion is now becoming slow. Dr. Doberck's elements are the best.

Some recent measures are :—

1880·55	253°·01	1″·83, Doberck.
1882·49	255 ·0	1 ·58, ,,
1883·38	254 ·5	1 ·84, Engelmann.
1885·482	258 ·05	1 ·79, Tarrant (*A.N.*, 2866).
1886·62	256 ·2	1 ·85, Jedrzejewicz.
1887·09	252 ·0	1 ·72, Schiaparelli.
1888·53	254 ·7	1 ·92, Leavenworth.

A list of measures by Dr. Doberck, from 1876 to 1882, will be found in the *Transactions* of the Royal Irish Academy, vol. xxix., part xiii. (1890).

45. 70 (γ) Ophiuchi = Σ 2272. More than a complete revolution of this well-known binary star has now been described since its discovery by Sir W. Herschel in 1779. Numerous orbits have been computed, but my elements represent recent measures better than others.

Some recent measures are :—

1886·528	:	13°·8	:	1″·98,	Hall.
1886·657	:	14 ·08	:	1 ·814,	Schiaparelli.
1886·67	:	14 ·86	:	1 ·88,	Engelmann.
1886·67	:	13 ·7	:	2 ·01,	Jedrzejewicz.
1886·76	:	14 ·53	:	2 ·07,	Tarrant.
1887·611	:	3 .6	:	1 ·93,	Hall.
1887·631	:	4 ·36	:	1 ·89,	Schiaparelli.
1887·812	:	3 ·49	:	1 ·91,	Tarrant (*A.N.*, 2898).
1887·86	:	2 ·50	:	2 ·35,	Young.
*1888·619	:	350 ·47	:	1 ·78,	Tarrant.
*1888·650	:	352 ·4	:	2 ·14,	Leavenworth.
*1889·30	:	348 ·7	:	2 ·16,	Burnham (36-inch refractor). "Both stars single with 36-inch."

The measures marked with an asterisk were made since my orbit was published (*Mon. Notices*, R. A. S., March, 1888). My elements give for these epochs :—

1888·619	:	353°·63	:	1″·86.
1888·650	:	353 ·27	:	1 ·87.
1889·30	:	346 ·05	:	1 ·92.

My elements, combined with Krüger's parallax of 0″·162, give for the combined mass of the components = 2·777 times the sun's mass, and a mean distance of 27·77 times the sun's mean distance from the earth. The mass is, therefore, about the same as that of the Sirian system.

I find that the plane of my orbit is at right angles to the plane of the Milky Way.

46. ζ Sagittarii. Recent measures seem to show that my elements are not far from the truth, but indicate that the period is slightly

longer than that given in the Catalogue. Some recent measures are:—

1886·5695	:	269°·6	:	0″.71,	Hall.
1886·5722	:	276 ·6	:	0 ·66,	,,
1886·6023	:	274 ·3	:	0 ·58,	,,
1886·7064	:	264 ·9	:	0 ·67,	,,
1886·739	:	271 ·0	:		Less than ½″, Pollock.
1888·62	:	257 ·4	:	0 ·70,	Burnham (6 nights.)
1888·707	:	260 ·2	:	0 ·68,	Leavenworth.
1889·41	:	255 ·1	:	0 ·81,	Burnham (*A.N.*), 2957.

47. γ Coronæ Australis. The period of this remarkable binary is certainly longer than that found by Downing and Schiaparelli, and apparently somewhat longer than that given by my orbit. Powell's elements are perhaps the best hitherto published. These show, however, the distance at present diminishing, whereas recent measures seem to show that it is on the increase. Some recent measures are:—

1886·615	:	200°·59	:	1″·45,	Pollock.
1887·714	:	196 ·7	:	1 ·68,	Tebbutt (3 nights).
1887·767	:	194 ·7	:	—	,, (1 night).
1888·307	:	192 ·4	:	1 ·59	,, ,,
1888·637	:	187 ·8	:	1 ·77	,, (4 nights).
1888·707	:	188 ·0	:	—	Leavenworth.
1888·809	:	191 ·9	:	2 ·30,	Tebbutt (2 nights).
1888·843	:	185 ·4	:	—	,, (4 nights).
1889·41	:	185 ·4	:	1 ·79,	Burnham (*A.N.*, 2957).

Mr. Tebbutt's measures were communicated to me by private letter. In his letter he says: "The measures of position angle are much more easily made than in former years, as the distance between the components has sensibly increased." If this be so, a really good orbit of this interesting binary has yet to be computed.

48. δ Cygni = Σ 2579. A difficult double star to measure, owing to the great inequality in the brightness of the components. My orbit represents all the measures of position angle fairly well, but gives the distance apparently somewhat too large at the earlier epochs. Dunér suggested that Sir W. Herschel's measure in 1783 of 18° 21′ *n.f.* should read 18° 21′ *s.f.*; but, according to Sadler, the diagram in Herschel's MSS. lends no support to this hypothesis (*Observatory*,

Sept., 1886). In my computation of the orbit I have adopted the reading 18° 21′ *n. f.*, as recorded by Herschel.

Some recent measures are as follows:—

1882·84	:	321°·44	:	1″·752,	Engelmann.
1883·82	:	321 ·5	:	1 ·79,	„
1885·521	:	317 ·79	:	1 ·66,	Tarrant (*A.N.*, 2866).
1885·90	:	318 ·91	:	1 ·723,	Engelmann.
1886·435	:	318 ·3	:	1 ·71	("too large"), Tarrant.
1886·65	:	315 ·0	:	1 ·6,	J. J. M. Perry.
1887·50	:	315 ·83	:	—	Tarrant.

I find that the plane of Behrmann's second orbit is at right angles to the plane of the Milky Way.

49. O. Struve, 387. An arc of about 130° of the apparent orbit has been described since its discovery in 1842. Glasenapp's orbit represents the measures fairly well, considering the difficult character of the star and the discordancy of some of the measures.

Some recent measures are:—

1883·13	:	5°·5	:	0″·40,	Engelmann.
1886·516	:	0 ·89	:	0 ·45,	Tarrant (*A.N.*, 2866).
1886·76	:	357 ·05	:	(0 ·50),	H. Struve.
1887·552	:	357 ·79	:	0 ·54,	Schiaparelli.
1888·76	:	354 ·55	:	(0 ·55),	H. Struve.

50. O. Struve, 400. An arc of about 190° of the apparent orbit has been described since its discovery in 1844. My elements represent the measures to 1885 fairly well, but recent measures indicate that the orbit will require revision. These measures are, however, rather discordant:—

1885·715	:	149°·5	:	0″·3,	est. Young.
1885·731	:	139 ·5	:	>0 ·25	„
1886·663	:	107 ·6	:	0 ·44,	Hall.
1887·916	:	140 ·13	:	0 ·25,	Schiaparelli.

I find that the plane of the orbit is at right angles to the plane of the Milky Way.

51. β Delphini. The principal star of the wide double Σ 2704. It was discovered by Burnham in 1873. The period is short, but still somewhat uncertain.

Some of the later measures are:—

1883·25	:	183°·90	:	0″·194,	Engelmann.
1883·55	:	182 ·50	:	0 ·23,	Burnham.
1884·71	:	197 ·75	:	0 ·32,	Engelmann.
1886·91	:	219 ·5	:	0 ·39,	,,
1887·86	:	286 ·3	:	0 ·20,	Schiaparelli.
1888·65	:	310 ·1	:	0 ·29,	Burnham (7 nights).
1889·50	:	314 ·2	:	0 ·31,	,, (*A.N.*, 2957).

52. λ Cygni = O Σ 413. The arc described by the companion since its discovery in 1842 amounts to about 50°. Glasenapp's orbit represents the measures fairly well.

Some recent measures are:—

1886·516	:	77°·39	:	0″·60,	Tarrant (*A.N.*, 2866).
1886·78	:	75 ·50	:	0 ·77,	H. Struve.
1887·584	:	69 ·98	:	0 ·67,	Schiaparelli.
1887·826	:	71 ·81	:	0 ·63,	Tarrant (*A.N.*, 2899).
1888·83	:	70 ·60	:	—	H. Struve.

53. 4 Aquarii = Σ 2729. The companion has described an arc of about 180° of the apparent orbit since its discovery by Sir W. Herschel in 1783.

Some recent measures are:—

1881·52	:	159°·6	:	0″·52,	Burnham.
1887·823	:	170 ·49	:	0 ·53,	Tarrant (*A.N.*, 2899); "measured distance too large."

54. 61 Cygni = Σ 2758. This famous star has long been suspected of being a binary pair, but the matter seems still somewhat doubtful. If really binary the period is very long.

The following are some recent measures:—

1886·855	:	121°·03	:	21″·06,	Tarrant (*A.N.*, 2866).
1887·68	:	121 ·0	:	20 ·58,	Schiaparelli.

Burnham says (*A.N.*, 2957)—"1889·463 and 1889·502. Both stars single in the 36-inch with powers up to 1000."

An observation of Bradley's gives:—

1753·80 : 35°·4 : 19″·63.

Assuming a parallax of 0″·45 Peter's "final" orbit (period = 782·6 years) gives for the combined mass of the components 0·461 (sun's mass = 1), and a mean distance of 65·62 times the sun's mean distance from the earth. This orbit was used by me in computing the relative brilliancy given in the Catalogue.

55. δ Equulei = O Σ 535. This is the brighter component of the wide double star Σ 2777. It has the shortest period of any known binary, three revolutions having been completed since its discovery in 1852. The *period* found by Wrublewsky is probably not far from the truth, but his orbit does not represent the measures very satisfactorily.

Some recent measures are :—

1883·55 :	307°·6 :	0″·21, Burnham.
1887·88 :	203 ·2 :	0 ·47, Schiaparelli.
1888·60 :	213 ·4 :	0 ·35, Leavenworth.
1888·69 :	189 ·9 :	0 ·25, Burnham.

Burnham says (*A.N.*, 2957)—"1889·515, slight elongation with the 36-inch in the direction of 343°·2. Distance not more than 0″·10."

56. τ Cygni = A. Clark, 13. Recent measures show that my orbit will require revision.

Some of these measures are :—

1880·78 :	137°·4 :	1″·04, Frisby.
1888·733 :	"Single, with all powers up to 3300. Good definition."	Burnham.
1889·49 :	36°·5 :	0″·50, Burnham.

57. ζ Aquarii = Σ 2909. An arc of only about 53° of the apparent orbit has been described since its discovery by Sir W. Herschel in 1779. The period found by Doberck is the longest yet computed for any binary star.

Some recent measures are :—

1885·720 :	328°·0 :	3″·330, Perrotin.
1886·945 :	326 ·53 :	3 ·43, Tarrant (*A.N.*, 2866).
1888·93 :	325 ·8 :	3 ·08, Leavenworth (6 nights).

58. π Cephei = O Σ 489. About 40° of the apparent orbit has been described since 1846. Glasenapp's elements represent the measures closely.

Some recent measures are:—

1883·86	32°·16	1″·34, Engelmann.
1888·67	32 ·50	1 ·16, H. Struve.

59. 85 Pegasi. The companion has described about 222° of its apparent orbit since its discovery in 1878. Owing to the faintness of the small star the pair has always been a difficult object, even with large telescopes.

Recent measures are:—

1888·69	126°·7	0″·95, Burnham (36-inch refractor).
1889·59	134 ·7	0 ·94, Burnham.
1890·55	139 ·0	0 ·78, ,, (*private letter*).

I find that the proper motion of 85 Pegasi is 1″·221 in the direction 141°·25. (See *Monthly Notices*, R. A. S., April, 1889.)

NOTES ADDED IN THE PRESS.

Professor Pickering says that, in the spectra of Σ 228 and 42 Comæ Berenices, "the hydrogen lines are strong in the ultra violet portion of the spectrum," a fact which seems "to indicate that the fainter component is of the first type" (*private letter*, July, 1890).

4. O Σ 20 = 66 Piscium:—

1886·656	351°·5	0″·45, Leavenworth.

8. 40 Eridani (BC). Other measures are:—

1886·001	112°·2	3″·22, Leavenworth.
1888·869	105 ·5	2 ·81, Tarrant.

18*a*. O Σ 215. My elements represent all the measures fairly well, both in angle and distance. The change of position angle has been very slow, owing to the fact that the companion has been moving

round the apoastron end of the orbit since 1844. Although the change in position angle has been only about 52°, there has been a change in the mean anomaly of nearly 146°. A recent measure is—

1888·26 : 214°·30 : 0″·77, Schiaparelli.

29. ξ Boötis—

1889·615	249°·9	3″·306	Maw (*Observatory*, Nov. 1890).
1890·409	246 ·2	3 ·15	,, ,,

31. η Coronæ Borealis = Σ 1937—

1887·427 : 186°·6 : 0″·82, Hough (*A.N.*, 2978).

38. ζ Herculis—

1889·64 : 71°·8 : 1″·55, Hough (*A.N.*, 2978).

42. Σ 2173. Owing to the high inclination of the real orbit, the apparent orbit is a very elongated ellipse.

43. μ' Herculis. Other measures are:—

1882·54	258°·9	0″·87	Hough (*A.N.*, 2978).
1889·51	357 ·9	0 ·55	Burnham (*A.N.*, 2957).

45*a*. 99 Herculis = A.C. 15. A binary star discovered by Alvan Clark, at Dawes' Observatory, in 1859. As the distance is now small, and the companion very faint, the object is at present beyond the reach of all but the largest telescopes. My orbit represents the measures fairly well. The minimum distance seems to have occurred about 1885·50, when the position angle was 156°·75, and the distance about 0″·18. The distance is now increasing. Some recent measures are:—

1881·43	29°·4	0″·51	Burnham (*A.N.*, 2957).
1888·733	Single with 36-inch refractor, Burnham.		
1889·502	281°·2	0″·65	Burnham (*A.N.*, 2957).
1890·45	285 ·1	0 ·56	,, (*private letter*).

46. ζ Sagittarii—

1886·772	271 ·9	0″·53	Leavenworth.
1890·49	251 ·1	0 ·76	Burnham (*private letter*).

50. O. Σ 400. Professor Hough gives—

1887·709 :	122°·7 :	0″·3 ±. "Distance probably less than 0″·30" (*A.N.*, 2978).

51. β Delphini. Other measures are—

1886·886 :	238°·12 :	0″·22, Schiaparelli.
1887·553 :	278 ·52 :	0 ·36, Tarrant.
1887·747 :	308 ·1 :	0 ·3 ±, Hough (*A.N.*, 2978).
1890·49 :	324 ·2 :	0 ·45, Burnham (*private letter*).

52. λ Cygni = O. Σ, 413—

1887·70 :	76°·0 :	0″·74, Hough (*A.N.*, 2978).

53. 4 Aquarii = Σ 2729—

1886·746 :	168°·3 :	0″·54, Leavenworth.

55. δ Equuleii :—

1887·78 :	195°·2 :	0″·49, Hough (*A.N.*, 2978).
1889·824 :	193 ·1 :	0 ·2 ±, ,, ,,

Professor Hough says :—"The distance in 1889 is certainly less than 0″·3."

56. τ Cygni. Other measures are :—

1886·887 :	80° ± :	0″·5 ±, Hough.
1887·758 :	56 ·4 :	0 ·4 ±, ,,
1890·54 :	20 ·5 :	0 ·54, Burnham (*private letter*).

57. ζ Aquarii—

1886·791 :	147°·8 :	3″·54, Leavenworth.

This measure seems to require a correction of 180°.

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1891.

TABLE SHOWING THE NUMBER OF ORBITS CALCULATED BY EACH COMPUTER.

Computer.	No.	Computer.	No.
Doberck.	34	Schur.	2
Mädler.	26	Smyth.	2
Gore.	19	O. Struve	2
Hind.	13	Winogradsky.	2
Jacob.	10	Adams.	1
Glasenapp.	8	Auwers.	1
Sir John Herschel.	8	Ball.	1
Powell.	8	Breen.	1
Villarceau.	8	Colbert.	1
Klinkerfues.	6	Copeland.	1
Mann.	6	Prince Dolgorukow.	1
Casey.	5	Elkin.	1
Celoria.	5	Grüber.	1
Dunér.	5	Henderson.	1
Pritchard.	4	Knott.	1
Downing.	3	Leuschner.	1
Flammarion.	3	Savary.	1
Peters.	3	Schaeberle.	1
Thiele.	3	Schiaparelli	1
J. M. Wilson.	2	Von Fuss.	1
Berberich.	2	Wijkander.	1
Doubjago.	2	H. C. Wilson.	1
Encke.	2	Winnecke.	1
Fletcher.	2	Wrublewsky.	1
Fritsche.	2		
Plummer.	2		
Seeliger.	2		

XLVII.

APPLICATIONS OF THE METHOD OF OPERATIVE SYMBOLS. By M. W. CROFTON, F. R. S.

(COMMUNICATED BY JOHN CASEY, LL.D., F.R.S.)

[Read November 10, 1890.]

A few applications of symbolical methods to Lagrange's expansion, and one or two other questions in the Differential Calculus, are given in this short Paper.

1. Lagrange's theorem is:—If s depends on x by the relation[1]

$$s = x + \phi(s), \tag{1}$$

$$F(s) = F(x) + \phi(x) F'(x) + \frac{D(\phi x)^2 F'x}{1 . 2} + \frac{D^2(\phi x)^3 F'x}{1 . 2 . 3} + \&c.$$

A more symmetrical form is, putting $\phi(x) = \phi$,

$$F(s) = D^{-1}\left\{1 + \frac{D\phi}{1} + \frac{D^2\phi^2}{1 . 2} + \dots \right\} DF(x);$$

or if we put Ω for the operator

$$\Omega = 1 + D\phi + \frac{D^2\phi^2}{1 . 2} + \frac{D^3\phi}{1.2.3} + \&c.$$

$$F(s) = D^{-1}\Omega DF(x); \tag{2}$$

or differentiating both sides

$$F'(s)\frac{ds}{dx} = \Omega F'(x);$$

or putting F for F', for any function F we shall have

$$\Omega F(x) = F(s)\frac{ds}{dx}, \tag{3}$$

we shall find this is a case of the following:—If any operand be understood on both sides

$$\Omega F(x) = F(s)\,\Omega. \tag{4}$$

---

[1] No generality is gained by writing y before $\phi(s)$, as usually done.

To prove this, we have in general[1]

$$f(D)\,x = xf(D) + f'(D)\,;$$

$$\therefore\ D^r x - xD^r = rD^{r-1}\,;$$

$$\therefore\ \frac{D^r\phi^r}{\lfloor r}\,x - x\,\frac{D^r\phi^r}{\lfloor r} = \frac{D^{r-1}\phi^r}{\lfloor r-1} = \frac{D^{r-1}\phi^{r-1}}{\lfloor r-1}\,\phi.$$

Hence it is easy to see that

$$\Omega x - x\Omega = \Omega\phi\,;$$

$$\therefore\ \Omega\,(x - \phi\,(x)) = x\Omega = (z - \phi\,(z))\,\Omega. \qquad (5)$$

Hence (by writing $x - \phi(x)$ after each side of (5), &c.) it is easy to show for any power, positive or negative, of $x - \phi(x)$,

$$\Omega\,(x - \phi x)^r = (z - \phi z)^r\,\Omega,$$

we conclude that for any function[2]

$$\Omega f(x - \phi x) = f(z - \phi z)\,\Omega\,;$$

or, as any function of x can be put in the form $f(x - \phi x)$,

$$\Omega F(x) = F(z)\,\Omega.$$

If, now, 1 be taken as operand[3]

$$\Omega F(x)\,| = F(z)\,\Omega 1.$$

Now, $$\Omega 1 = \left(1 + D\phi + \frac{D^2\phi^2}{2} + \frac{D^3\phi^3}{\lfloor 3} + \ldots\right)1$$

$$= 1 + \phi' + \frac{D\phi\phi'}{1} + \frac{D^2\phi^2\phi'}{1\,.\,2} + \ldots$$

$$= 1 + \Omega\phi'(x) = 1 + \phi'(z)\,\Omega 1\,;$$

$$\therefore\ \Omega 1 = \frac{1}{1 - \phi'(z)} = \frac{dz}{dx}\,; \qquad (6)$$

thus equation (3), *i.e.* Lagrange's theorem, is proved.

---

[1] An operand will be understood in all cases, unless otherwise stated.

[2] First for any rational integral function; any other function can be expressed as a series of rational integral functions.

[3] A vertical bar indicates that the operations terminate there.

By putting in (2) $F(z-\phi z)$ for $F(z)$, we have the result

$$F(x) = D^{-1}\Omega DF(x-\phi(x)),$$

which we observe is independent of z, or of the equation (1). For instance, let $\phi(x) = x^2$,

$$D^{-1}\left(1+\frac{Dx^2}{1}+\frac{D^2x^4}{1.2}+\ldots\right)DF(x-x^2) = F(x). \tag{7}$$

2. Several curious results as to infinite series follow from Lagrange's theorem: thus, if $z = x + y\phi(z)$, and we write $\phi = \phi(x)$, (the operand is 1)

$$(\phi z)^n = \phi^n + \left(y\phi + \frac{y^2}{1.2}D\phi^2 + \frac{y^3}{1.2.3}D^2\phi^3 + \ldots\right)n\phi^{n-1}\phi'$$

$$= \phi^n + n\left(\frac{yD\phi^{n+1}}{n+1} + \frac{y^2}{1.2}\frac{D^2\phi^{n+2}}{n+2} + \ldots .\right);$$

let $n = 1$, then

$$\phi z = \phi + \frac{y}{2}D\phi^2 + \frac{y^2}{1.2.3}D^2\phi^3 + \ldots .$$

we thus obtain the n^{th} power of this series, viz. if ϕ be any function of x,

$$\left(\phi+\frac{y}{2}D\phi^2+\frac{y^2}{1.2.3}D^2\phi^3+\ldots\right)^n = \phi^n + n\left[y\frac{D\phi^{n+1}}{n+1}+\frac{y^2}{1.2}\frac{D^2\phi^{n+2}}{n+2}+\ldots .\right]; \tag{8}$$

thus let $\phi = e^x$, by reducing and putting $h = ye^x$,

$$\left(1+h+\frac{3}{1.2}h^2+\frac{4^2}{\lfloor 3}h^3+\frac{5^3}{\lfloor 4}h^4+\ldots\right)^n =$$

$$1+n\left[h+\frac{n+2}{\lfloor 2}h^2+\frac{(n+3)^2}{\lfloor 3}h^3+\frac{(n+4)^3}{\lfloor 4}h^4+\ldots\right];$$

if $n = -1$,

$$\left(1+h+\frac{3}{1.2}h^2+\&c.\right)^{-1} = 1-h-\frac{h^2}{\lfloor 2}-2^2\frac{h^3}{\lfloor 3}-3^3\frac{h^4}{\lfloor 4}-\&c.$$

Again, let $z = x + e^z$, so that

$$\Omega = 1 + De^x + \frac{D^2e^{2x}}{\lfloor 2} + \&c.$$

$$\Omega e^x \,| = e^z\frac{dz}{dx}, \text{ but (2) } e^z = D^{-1}\Omega e^x, \text{ and } \frac{dz}{dx} = \Omega 1.$$

Hence, by reducing, we find

$$\left[1+h+\frac{(2h)^2}{\lfloor 2}+\frac{(3h)^3}{\lfloor 3}+\ldots\right]\times\left[1+\frac{2h}{\lfloor 2}+\frac{(3h)^2}{\lfloor 3}+\frac{(4h)^3}{\lfloor 4}+\ldots\right]$$

$$=1+2h+\frac{(3h)^2}{\lfloor 2}+\frac{(4h)^3}{\lfloor 3}+\frac{(5h)^4}{\lfloor 4}+\ldots.$$

Such results are not easy to verify by common algebra.

3. The reciprocal or inverse of the operator

$$\Omega=1+D\phi x+\frac{D^2(\phi x)^2}{\lfloor 2}+\frac{D^3(\phi x)^3}{\lfloor 3}+\ldots.$$

is

$$\Omega'=1-D\phi z+\frac{D^2(\phi z)^2}{\lfloor 2}-\frac{D^3(\phi z)^3}{\lfloor 3}+\ldots.$$

where D, as always, stands for $\dfrac{d}{dx}$.

This may be seen in different ways; I will use the following. Let us put

$$\phi(z)=\psi(x);\quad \therefore\ z=x+\psi(x),$$

then

$$\Omega'=1-D\psi x+\frac{D^2(\psi x)^2}{\lfloor 2}-\&c.$$

Hence (2)

$$D^{-1}\Omega' DF(x)=F(w),$$

where

$$w=x-\psi(w).$$

Now $\qquad F(z)=F(x+\psi x)=D^{-1}\Omega DF(x)$

operate on both sides with $\qquad D^{-1}\Omega' D,$

$$D^{-1}\Omega' DF(x+\psi x)=D^{-1}\Omega'\Omega DF(x);$$

$$\therefore\ F(w+\psi w)=F(x)=D^{-1}\Omega'\Omega DF(x);$$

$$\therefore\ D^{-1}\Omega'\Omega D=1;\quad \therefore\ \Omega'\Omega=1.$$

As an instance, let $\phi(x)=x-x^2$, and we have the theorem :—The two operators

$$1+D(x-x^2)+\frac{1}{1.2}D^2(x-x^2)^2+\&c.$$

$$1-D(x^{\frac{1}{2}}-x)+\frac{1}{1.2}D^2(x^{\frac{1}{2}}-x)^2-\&c.$$

are reciprocals.

4. It will be useful to state here certain formulas in the Calculus of Operations, some of which are not new, before considering one or two questions in the Differential Calculus to which we will apply them. I would refer to a Paper on the subject in the *Quarterly Journal of Mathematics*, Oct., 1879, and to one in the *Proceedings of the London Mathematical Society*, vol. xii. If $a(x)$ be any function,

$$f(D + a'(x)) = e^{-a(x)} f(D)\, e^{a(x)}, \tag{1}$$

$$f(x + a'(D)) = e^{a(D)} f(x)\, e^{-a(D)}, \tag{2}$$

hence
$$f(x + D) = e^{-\frac{1}{2}x^2} f(D)\, e^{\frac{1}{2}x^2} = e^{\frac{1}{2}D^2} f(x)\, e^{-\frac{1}{2}D^2}; \tag{3}$$

we shall easily find from (1) and (2),

$$f(D + ax) = e^{-\frac{1}{2}ax^2} f(D)\, e^{\frac{1}{2}ax^2} = e^{\frac{1}{2}a^{-1}D^2} f(ax)\, e^{-\frac{1}{2}a^{-1}D^2}. \tag{4}$$

Put here $f(D) = D^r$, and let the operand be unity, and we find

$$D^r e^{\frac{1}{2}ax^2} = e^{\frac{1}{2}ax^2} a^r e^{\frac{1}{2}a^{-1}D^2} x^r,$$

or

$$D^r e^{\frac{1}{2}ax^2} = e^{\frac{1}{2}ax^2}\left(a^r x^r + \frac{r(r-1)}{2} a^{r-1} x^{r-2} + \frac{r(r-1)(r-2)(r-3)}{2.4} a^{r-2} x^{r-4} + \ldots\right) \tag{5}$$

Since $Dx = xD + 1$, the operators Dx, xD are commutative, either being a function of the other, thus

$$xD^2x = Dx^2D.$$

Also, as we know that (see Art. 10, *infra*)

$$x^r D^r = xD(xD-1)\ldots(xD-r+1),$$

$$D^r x^r = Dx(Dx+1)\ldots(Dx+r-1),$$

the operators $D^r x^r$, $x^r D^r$, xD, Dx, or any functions of them, are commutative.

Hence we may prove the theorem

$$(DxD)^r = D^r x^r D^r. \tag{6}$$

For (by interchanging Dx, $x^{r-1}D^{r-1}$),

$$D^r x^r D^r = D^{r-1} Dx x^{r-1} D^{r-1} D = D^{r-1} x^{r-1} D^{r-1} DxD$$

$$= D^{r-2} x^{r-2} D^{r-2} (DxD)^2,$$

and so on. We may also deduce

$$(xDx)^r = x^r D^r x^r. \tag{7}$$

Again, $$(x^2D)^r = x^{r+1}D^r x^{r-1}, \tag{8}$$
for
$$(x^2D)^2 = x^2Dx^2D = x(xDx)(xDx)x^{-1},$$
$$(x^2D)^3 = x(xDx)^3x^{-1};$$
$$\therefore\ (x^2D)^r = x(xDx)^r x^{-1} = x^{r+1}D^r x^{r-1} \text{ by (7)}.$$

5. Let us now apply (8) to the question of finding the differential coefficients of $f(x^{-1})$, f being any function whose successive derived functions
$$f_1, f_2, f_3, \ldots .$$
are known. Let $x^{-1} = y$; then
$$\frac{dy}{dx} = -x^{-2} = -y^2;$$
now
$$\frac{d}{dx} = \frac{dy}{dx}\frac{d}{dy} = -y^2\frac{d}{dy},$$
$$D^r f(x^{-1}) = (-1)^r\left(y^2\frac{d}{dy}\right)^r f(y) = (-1)^r y^{r+1}\left(\frac{d}{dy}\right)^r y^{r-1}f(y).$$
Now
$$\left(\frac{d}{dy}\right)^r y^{r-1}f(y) = y^{r-1}f_r y + r(r-1)y^{r-2}f_{r-1}y + \frac{r(r-1)}{2}(r-1)(r-2)y^{r-3}f_{r-2}y + \ldots$$
Put x^{-1} for y, and we find $D^r f(x^{-1}) =$
$$(-1)^r x^{-2r}\{f_r(x^{-1}) + r(r-1)xf_{r-1}(x^{-1}) + \frac{r(r-1)}{2}(r-1)(r-2)x^2 f_{r-2}(x^{-1})$$
$$+\frac{r(r-1)(r-2)}{2.3}(r-1)(r-2)(r-3)x^3 f_{r-3}(x^{-1}) + \ldots\}$$[1]

---

[1] Some curious results in Algebra follow from this formula. Thus if
$$f(x) = x^{+n},\ f(x^{-1}) = x^{-n};$$
$$D^r f(x^{-1}) = D^r x^{-n} = (-1)^r n(n+1)\ldots(n+r-1)x^{-n-r}.$$
Now $f_r(x^{-1}) = n(n-1)\ldots(n-r+1)x^{-n+r}$, &c. Hence the above formula gives, on dividing by x^{-n-r},
$$\frac{n(n+1)(n+2)\ldots(n+r-1)}{n(n-1)(n-2)\ldots(n-r+1)} = 1 + r\frac{r-1}{n-r+1} + \frac{r(r-1)}{2}\cdot\frac{(r-1)(r-2)}{(n-r+1)(n-r+2)} + \text{\&c.}$$
If we take $f(x) = x^{-n}$, $f(x^{-1}) = x^n$, or change the sign of n,
$$\frac{n(n-1)(n-2)\ldots(n-r+1)}{n(n+1)(n+2)\ldots(n+r-1)} = 1 - r\frac{r-1}{n+r-1} + \frac{r(r-1)}{2}\,\frac{(r-1)(r-2)}{(n+r-1)(n+r-2)} - \text{\&c.},$$
which thus is the reciprocal of the former series.

6. Let us now consider $D^r f(x^n)$. We shall show that this can be reduced to the question of finding $D^r e^{ax^n}$. We first give one or two further theorems which will be employed.

If ϕ, f are any two functions

$$\phi\left(x+\frac{d}{dy}\right)f(y) = f\left(y+\frac{d}{dx}\right)\phi(x). \tag{9}$$

For either may be expressed in the form

$$e^{\frac{d}{dx}\frac{d}{dy}}\phi(x)f(y) = \phi(x)fy + \phi'(x)f'(y) + \tfrac{1}{2}\phi''(x)f''(y) + \ldots$$

Hence if f be a function such that it and its coefficients do not become infinite for $y = 0$,

$$\phi\left(x+\frac{d}{d0}\right)f(0) = f\left(\frac{d}{dx}\right)\phi(x). \tag{10}$$

Also, if both f, ϕ be such functions,

$$\phi\left(\frac{d}{d0}\right)f(0) = f\left(\frac{d}{d0}\right)\phi(0). \tag{11}$$

See Boole's *Finite Differences*, by Moulton, p. 23.

We may express the function $f(x + \phi(x))$ in the form

$$e^{\phi(\dot{x})D}f(x) = f(x + \phi(x)), \tag{12}$$

the operation indicated being performed *as if $\dot{x}$ were a constant independent of x*, which is replaced by x after the operation is concluded.

If we put

$$y = x^n,\ \frac{d}{dy} = \frac{1}{nx^{n-1}}\frac{d}{dx};$$

hence, putting ζ for the operator,

$$\zeta = n^{-1}x^{-n+1}D, \tag{13}$$

$$e^{h\frac{d}{dy}}f(y) = e^{h\zeta}f(x^n) = f(x^n + h),$$

$$e^{\phi(\dot{x})\zeta}f(x^n) = f(x^n + \phi(x)). \tag{14}$$

Also $\qquad \zeta f(x^n) = f_1(x^n),\ \ \zeta^2 f(x^n) = f_2(x^n),\ \&c.$

To find now the value of $D^r f(x^n)$, we have (10)

$$D^r f(x^n) = f\left(x+\frac{d}{d0}\right)^n 0^r,$$

$$=f\left(x^n - x^n + \left(x + \frac{d}{d0}\right)^n\right) 0^r,$$

$$= \exp.\left[\left(\dot{x} + \frac{d}{d0}\right)^n \zeta^n - \dot{x}^n \zeta\right] f(x^n)\, 0^r,$$

$$= e^{-\dot{x}^n \zeta} \exp.\left[\left(\dot{x} + \frac{d}{d0}\right)^n \zeta\right] 0^r f(x^n),$$

$$= e^{-\dot{x}^n \zeta} \left(\frac{d}{d0}\right)^r \exp. (\dot{x} + 0)^n \zeta f(x^n) \text{ by (11)};$$

$$\therefore\ D^r f(x^n) = e^{-\dot{x}^n \zeta} \left(\frac{d}{d\dot{x}}\right)^r e^{\dot{x}^n \zeta} f(x^n). \qquad (15)$$

Hence the question is reduced to finding the value of

$$\left(\frac{d}{d\dot{x}}\right)^r e^{\dot{x}^n \zeta},$$

where ζ is a constant as regards $\dot{x}$.

7. For example, let

$$n = 2, \quad \zeta = (2x)^{-1} D; \text{ by (5)},$$

$$\left(\frac{d}{d\dot{x}}\right)^r e^{\dot{x}^2 \zeta} = e^{\dot{x}^2 \zeta} \{\dot{x}^r (2\zeta)^r + \frac{r(r-1)}{2} \dot{x}^{r-2} (2\zeta)^{r-1} + \frac{r(r-1)(r-2)(r-3)}{2.4} \dot{x}^{r-4} (2\zeta)^{r-2} + \dots\}$$

Hence $D^r f(x^2) =$

$$(2x)^r f_r(x^2) + r(r-1)(2x)^{r-2} f_{r-1}(x^2) + \frac{r(r-1)(r-2)(r-3)}{1.2} (2x)^{r-4} f_{r-2}(x^2) + \dots \quad (16)$$

See Williamson's *Diff. Calc.*, p. 448.

This formula might be found independently of (15): thus

$$D^r f(x^2) = f\left(x^2 + 2x \frac{d}{d0} + \frac{d^2}{d0^2}\right) 0^r = e^{(2\dot{x}d + d^2)\zeta}\, 0^r f(x^2); \text{ putting } \frac{d}{d0} = d;$$

$$= e^{2\dot{x}\zeta d} (0^r + r(r-1)\, 0^{r-2} \zeta + \frac{r \,.\,. (r-3)}{1.2} 0^{r-4} \zeta^2 + \dots) f(x^2)$$

$$= [(2\dot{x}\zeta)^r + r(r-1)(2\dot{x}\zeta)^{r-2} \zeta + \frac{r \,.\,. (r-3)}{1.2} (2\dot{x}\zeta)^{r-4} \zeta^2 + \dots] f(x^2),$$

giving the same result.

8. So little do we understand the methods of dealing with the symbols we are considering, that it may be useful to show how the formula (15) may be arrived at by another process.

First, let us state a principle (referred to in the Paper, *London Math. Soc. Proc.*, vol. xii.) that in any operator

$$U = f(x, D)$$

we may substitute for D, $D + \dot{D}$; understanding that $\dot{D}$ solely affects the x which is contained in U, and that D is constant or inoperative as regards this x, and only operates on the x which enters the operand which follows.

This may be expressed thus:—

$$U = f(x, D) = f(\dot{x}, \dot{D} + D), \tag{17}$$

where $\dot{D} = \frac{d}{d\dot{x}}$, and $\dot{x}$ is regarded as a quantity independent of x, which is to be replaced by x at the end of the operations.

For instance, we have

$$(xD)^2 = [\dot{x}(\dot{D} + D)]^2 = \dot{x}(\dot{D} + D)\,\dot{x}(\dot{D} + D)$$
$$= \dot{x}(\dot{D} + D)\,\dot{x}D, \text{ since } \dot{D} \cdot 1 = 0;$$
$$\therefore\ (xD)^2 = \dot{x}^2D^2 + \dot{x}D = x^2D^2 + xD.$$

It is easy to show also that

$$(xD)^3 = x^3D^3 + 3x^2D^2 + xD,$$
$$(x^2D^2)^2 = x^4D^4 + 4x^3D^3 + 2x^2D^2.$$

Now let us consider

$$D^rf(x^n): \text{ if } y = x^n,\ \frac{d}{dx} = nx^{n-1}\frac{d}{dy};$$

$$\therefore\ D^rf(x^n) = \left(nx^{n-1}\frac{d}{dy}\right)^r f(x^n) = \left[n\dot{x}^{n-1}\left(\frac{d}{d\dot{y}} + \frac{d}{dy}\right)\right]^r f(x^n)$$

where $\dot{x}^n = \dot{y}$.
$$= \left(\frac{d}{d\dot{x}} + n\dot{x}^{n-1}\frac{d}{dy}\right)^r f(x^n);$$

now if we put (13) $\quad \zeta = n^{-1}x^{-n+1}\frac{d}{dx},\ \zeta = \frac{d}{dy},\quad$ and we have

$$D^rf(x^n) = \left(\frac{d}{d\dot{x}} + n\dot{x}^{n-1}\zeta\right)^r f(x^n), \tag{18}$$

but as ζ is constant as to $\dot{x}$, we have by formula (1) above

$$D^rf(x^n) = \epsilon^{-\dot{x}^n\zeta}\left(\frac{d}{d\dot{x}}\right)^r \epsilon^{\dot{x}^n\zeta}f(x^n), \text{ as in (15).}$$

9. To find the value of $D^r e^{\frac{1}{3}ax^3}$, which will lead to that of $D^r f(x^3)$, we may proceed as follows :—

$$D^r e^{\frac{1}{3}ax^3} = \exp.\left(\tfrac{1}{3}a\left(x+\frac{d}{d0}\right)^3\right)0^r;\ \text{by (10)}$$

$$= e^{\frac{1}{3}ax^3}\, e^{ax^2d}\, e^{axd^2}\, e^{\frac{1}{3}ad^3}\, 0^r,\ \text{putting } d \text{ for } \frac{d}{d0}.$$

Now

$$e^{\frac{1}{3}ad^3}\, 0^r = 0^r + \frac{r(r-1)(r-2)}{3}\, a0^{r-3} + \frac{r(r-1)(r-2)(r-3)(r-4)(r-5)}{3.6}\, a^2 0^{r-6} + \dots.$$

operate on both sides by e^{axd^2}; and

$$e^{axd^2}\, e^{\frac{1}{3}d^3}\, 0^r = e^{axd^2}\, 0^r + \frac{r(r-1)(r-2)}{3}\, a e^{axd^2}\, 0^{r-3} + \&c.,$$

so that if we write

$$e^{axd^2} 0^r = 0^r + r(r-1)\, ax\, 0^{r-2} + \frac{r(r-1)(r-2)(r-3)}{1.2}\, a^2x^2\, 0^{r-4} + \dots = F(r),$$

$$e^{axd^2}\, e^{\frac{1}{3}d^3}\, 0^r = F(r) + \frac{r(r-1)(r-2)}{3}\, aF(r-3) + \frac{r\dots.(r-5)}{3.6}\, a^2F(r-6) + \dots$$

If we now operate on both sides by e^{ax^2d}, the effect will be to change 0 everywhere into ax^2. Hence if we put

$$f(r) = (ax^2)^r + r(r-1)\, ax\, (ax^2)^{r-2} + \frac{r(r-1)(r-2)(r-3)}{1.2}\, a^2x^2\, (ax^2)^{r-4} + \dots$$

$$\left.\begin{aligned} &\text{or if}\quad f(r) = a^r x^{2r} + r(r-1)\, a^{r-1} x^{2r-3} + \frac{r(r-1)(r-2)(r-3)}{1.2}\, a^{r-2} x^{2r-6} + \&c. \\ &e^{-\frac{1}{3}ax^3} D^r e^{\frac{1}{3}ax^3} = f(r) + \frac{r(r-1)(r-2)}{3}\, af(r-3) + \frac{r\dots(r-5)}{3.6}\, a^2f(r-6) + \dots \end{aligned}\right\}\ (19)$$

If we put $a = \zeta = (3x^2)^{-1}D$, as

$$\zeta F(x^3) = F_1(x^3),\quad \zeta^2 F(x^3) = F_2(x^3),\ \&c.,$$

this formula will at once (15) give the value of $D^r F(x^3)$.

10. One or two formulas of some interest are added:—Equation (1) gives

$$e^{h(D+a'x)} = e^{-a(x)}\, e^{hD}\, e^{a(x)} = e^{a(x+h)-a(x)}\, e^{hD};$$

thus $$e^{h(D+x)} = e^{\frac{1}{2}(x+h)^2-\frac{1}{2}x^2}\, e^{hD} = e^{\frac{1}{2}h^2}\, e^{hx}\, e^{hD};$$

hence the result of any such operator on $F(x)$ is found, as

$$e^{hD} F(x) = F(x+h).$$

Since $(1-a)^{-Dx} = 1 + aDx + \frac{a^2}{1.2} Dx(Dx+1) + \frac{a^3}{1.2.3} Dx(Dx+1)(Dx+2) + \ldots$

$$= 1 + aDx + \frac{a^2}{1.2} D^2x^2 + \frac{a^3}{1.2.3} D^3x^3 + \ldots.$$

we have thus

$$\left(1 + aDx + \frac{a^2}{2} D^2x^2 + \ldots\right) F(x) = (1-a)^{-1} F\left(\frac{x}{1-a}\right), \tag{20}$$

since $\qquad Dx = 1 + xD, \text{ and } n^{xD} f(x) = f(nx).$

By (6)—

$$\epsilon^{DxD} = 1 + DxD + \frac{D^2x^2D^2}{1.2} + \ldots$$

Hence

$$\epsilon^{DxD}\epsilon^{hx} = \left(1 + hDx + \frac{h^2}{2} D^2x^2 + \ldots\right)\epsilon^{hx} = (1-h)^{-1} \exp.\left(\frac{hx}{1-h}\right).$$

This formula (20) is a case of Lagrange's theorem.

Since $\qquad Dx^{-r} = x^{-r}D - rx^{-r-1},\ Dx + r = x^{-r}Dx^{r+1}, \qquad (21)$

and since $\qquad D^{-r}x = xD^{-r} - rD^{-r-1},\ Dx + r = D^{r+1}xD^{-r}. \qquad (22)$

From (21)

$$Dx(Dx+1) = Dxx^{-1}Dx^2 = D^2x^2,$$

$$Dx(Dx+1)(Dx+2) = D^2x^2x^{-2}Dx^3 = D^3x^3,$$

$$Dx(Dx+1)\ldots(r \text{ factors}) = D^rx^r.$$

(See Williamson, *Diff. Calc.*, p. 449.)

As these factors are commutative, we may reverse the order, which will give

$$D^rx^r = x^{-r+1}(Dx^2)^r x^{-1}, \tag{23}$$

and (22) gives $\qquad D^rx^r = D^{-1}(D^2x)^r D^{-r+1}; \qquad (24)$

$$\therefore\ (Dx^2)^r = x^{r-1}D^rx^{r+1},\ (D^2x)^r = D^{r+1}x^rD^{r-1}. \tag{25}$$

Since, if ϕ be any function of x, ϕ' its derived function

$$D\phi^{-r} = \phi^{-r}D - r\phi^{-r-1}\phi',$$

$$D\phi + r\phi' = \phi^{-r}D\phi^{r+1}.$$

Hence is instantly proved the formula

$$D^r\phi^r = D\phi(D\phi + \phi')(D\phi + 2\phi')\ldots(r \text{ factors}),$$

11. By the method in formula (20) a curious proof may be obtained of a theorem in operations found by another process in *Phil. Trans.* for 1869, p. 186 (see also Forsyth, *Diff. Eq.*, p. 353)

$$(1-a)^{-\frac{1}{2}Dx} = 1 + \frac{a}{2}Dx + \frac{a^2}{2.4}Dx(Dx+2) + \frac{a^3}{2.4.6}Dx(Dx+2)(Dx+4) + \ldots$$

Now, $$Dx+2 = D^3 x D^{-2};\quad \therefore\ (Dx+2)\,Dx = D^4(D^{-1}x)^2,$$
$$(Dx+4)\,(Dx+2)\,Dx = D^6(D^{-1}x)^3,\ \ \&c.;$$
also $$(1-a)^{-\frac{1}{2}Dx}\,F(x) = (1-a)^{-\frac{1}{2}}\,F\left(\frac{x}{\sqrt{1-a}}\right),$$
hence
$$(1+\frac{a}{2}D^2(D^{-1}x)+\frac{a^2}{2.4}D^4(D^{-1}x)^2+\&c.)\,F(x) = (1-a)^{-\frac{1}{2}}F\left(\frac{x}{\sqrt{1-a}}\right). \quad (26)$$

Let $F(x) = e^{\frac{1}{2}kx^2}$, then $(D^{-1}x)^r\,F(x) = k^{-r}F(x)$;
$$\therefore\ (1+\frac{ak^{-1}}{2}D^2+\frac{a^2k^{-2}}{2.4}D^4+\ldots)\,e^{\frac{1}{2}kx^2} = (1-a)^{-\frac{1}{2}}\exp.\left(\frac{\frac{1}{2}kx^2}{1-a}\right);$$
put $a = kh$, and we have the theorem in question, viz.:—
$$e^{\frac{1}{2}hD^2}\,e^{\frac{1}{2}kx^2} = (1-hk)^{-\frac{1}{2}}\exp.\left(\frac{\frac{1}{2}kx^2}{1-hk}\right).$$

In like manner, it can be shown that
$$(1-a)^{-\frac{1}{3}Dx} = 1+\frac{a}{3}D^3(D^{-2}x)+\frac{a^2}{3.6}D^6(D^{-2}x)^2+\&c.$$

If, then, we can find a function y such that $D^{-2}xy = y$: that is, if $y = F(x)$ be the transcendent derived from the differential equation
$$\frac{d^2y}{dx^2} = xy,$$
then $$e^{\frac{1}{3}aD^3}\,F(x) = (1-a)^{-\frac{1}{3}}F\left(\frac{x}{(1-a)^{\frac{1}{3}}}\right).$$

By formula (22) we may derive, as above,
$$Dx\,(Dx+2)\,(Dx+4)\ldots.(r\text{ factors}) = D^{2r}(D^{-1}x)^r,$$
and by (21) $$= (Dx^{-1})^r\,x^{2r};$$
$$\therefore\ D^{2r}(D^{-1}x)^r = (Dx^{-1})^r\,x^{2r} \quad (27)$$
for any operand.

XLVIII.

SECOND REPORT ON THE PREHISTORIC REMAINS FROM THE SANDHILLS OF THE COAST OF IRELAND. By W. J. KNOWLES. (Plates XXII., XXIII., XXIV.)

[Read January 12, 1891.]

Since furnishing my last Report,[1] I have spent the leisure time of two seasons in endeavouring to extend our knowledge in reference to sandhills in Ireland which contain prehistoric remains. I have been round the greater part of the coast of Donegal, with some success, and I have also been along the coasts of Sligo and Mayo, as far as Westport and Achill Island, making two visits to some places, but as yet I have not succeeded in finding sandhills containing such remains as I was in search of farther south than Killala. Altogether I have found three important stations, and some minor places in addition to those mentioned in my last Report, and might have had a larger list to record if I could have obtained any assistance or information from the people of the various neighbourhoods. The kind of investigation I was engaged in was new, and appeared to the people simple and frivolous. No one took any interest in sandhills, or could understand why I was inquiring after them. I had, therefore, to make a personal search, first for the sandhills, and then to see if they contained any relics. In this way a great deal of time was wasted, which under the circumstances could not be avoided; and I was, therefore, obliged to go on patiently, and be satisfied if I had one success amidst a great many disappointments. In addition to the search for new places I have done some digging at Whitepark Bay, one of the most productive sites, and have visited other places mentioned in my last Report for the purpose of determining questions of interest. My first tour was round the southern coast of Donegal, and though the results were rather meagre, still I found one small prehistoric station at Fintragh, and obtained other important information respecting the distribution of flint. All round the shore I found flint stones, some of which were two or three pounds in weight. Near Donegal town, among glaciated

[1] *Antea*, p. 173.

material, I found a flint boulder, weighing over a pound, in its natural state as it came from the chalk. Several other pieces of flint, deeply patinated and core-like in character, were picked up. The rocks in the neighbourhood of the shore show glacial grooving and scoring very plainly: therefore I believe that glaciers were the agents which brought the flint to Donegal Bay. The number of flint implements found amongst those of chert at Bundoran was considerable, and appeared to me at first to be an indication of commercial intercourse between the Stone Age people of Antrim and those of the West Coast of Ireland; but seeing that I cannot trace chert in any of the sites near Bundoran, and observing the coarse material used for implements in stations which could as easily have been reached by traders as Bundoran, I am of opinion that the flint implements found there are not an indication of trading, but that they were made from flint pebbles and boulders found on the seashore, and that these were derived from the boulder clay.

BUNBEG, CO. DONEGAL.

I visited Bunbeg in the summer of 1889, and found sandhills there with the old surface layer exposed in many places. I saw no flint, but in digging over the layer there was the usual mixture of shells, bones, and broken pieces of crystalline rock. I got several good and well-marked examples of hammerstones and two pieces of pottery without ornament, but with a small pole in each of them near the rim, probably for the purpose of suspending the vessel. The rounded, waterworn pebbles were evidently broken or split intentionally for implements, a very good cutting edge being formed by the junction of the fractured side of a spall or flake, with the rounded outside of the pebble. A flake of this kind could be used either as a scraper or an axe, but no one would be likely to take them for artificially produced flakes or implements if found alone. Finding them, however, in association with hammerstones, shells, and bones in the black layer, satisfies me that they were intentionally made for cutting and other purposes.

Skull Island is connected with these sandhills. It is described by Mrs. Craik in one of her articles entitled "An Unknown Country," in the *Englishwoman's Magazine* for May, 1887. On a visit which she made to the place she found to her amazement, in a heap of sand, "a quantity of bones—leg-bones, arm-bones, skulls—lying so close to the surface that, with a stick or umbrella, you could have digged them out of the sand by dozens." She disinterred two skulls, one of which got

accidentally broken; but she saved the other, and brought it safe to London, "and gave it to a learned friend, who admired it exceedingly; said the teeth were very remarkable, and the cranium also, being of a peculiar shape unknown among our modern races. Of its age, or or how long it had been buried, he could offer no conjecture." I examined this Island, and saw many fragments of human bones, but none entire or worth bringing away. I saw the remains of graves lined with thin slabs which appeared to have been covered with similar slabs. I was able to make out the ends in one or two cases, and found the graves to be between seven and eight feet in length. It appeared to me that the graves had been made on the ground formerly used as dwelling-places by the neolithic inhabitants, and that they were probably the graves of some later people. Similar graves were found a few years ago at Glenarm, which had been made in a field strewn with flakes, cores, and other evidences of a prehistoric dwelling-place or flint implement manufactory.

Ballyness, Co. Donegal.

In the *Ulster Journal of Archæology*, vol. vi. p. 351, there is an account of antiquities found on a part of the shore at Ballyness Bay the property of Wybrants Olphert, Esq., from which sandhills had been blown away, leaving exposed to view some confused remains of buildings. Upwards of fifty pins and fibulæ of bronze were found, of which thirteen are figured full size in that Journal. The writer says that not the least remarkable circumstance connected with the locality is that on the same spot, in which these undoubtedly ancient pins and fibulæ were found, coins and other articles of recent date have been picked up. Among these were coins of Elizabeth, James I., Charles I. and II., and William and Mary, together with tradesmen's tokens of the seventeenth century.

I called on Mr. Olphert in September, 1890, and he very kindly showed me the articles that had been found; and he and his daughter, Mrs. Kettlewell, gave me all the information they remembered respecting the various finds. The pins now number over one hundred, and are of various patterns. Two of them are shown in figs. 4 and 5, in Plate xxiv. The ring in fig. 4 is turned up to show the cross on the stem of the pin and the swastika on the head. Figs 4*a* and 4*b* show the ornamentation on the top and back of the head of this pin. Besides the pins there are many brooches or fibulæ, some of which are two inches in diameter, but others are very small, being not much over half an inch

in diameter and as thin almost as a piece of note-paper. In the small specimen, fig. 6, Plate xxiv., the red enamel in the rounded ends is still perfect. There are also safety-pin brooches, one of which is shown in fig. 2, Pl. xxiv.; tweezers, fig. 7; a small bronze key of curious pattern, with split instead of pipe shown in fig. 10; shoe-buckles; studs, with nail-like projections of about an inch in length and terminating in an eye, supposed to have belonged to a harness; a letter P of bronze about three quarters of an inch in length with similar nail-like projection terminating in an eye; bronze needles one of which is shown in fig. 8, Plate xxiv., bodkins, sleevelinks, one pair of which had the compass and square and other masonic emblems engraved on them; a bronze or brass ring, spindle-whorls, and beads of stone, glass beads ornamented with yellow enamel or paste and spiral threads of glass of various colours; clay pipes of the kind known as "Danes' pipes," pieces of chain formed of thin wire besides some other articles. One object is shown in fig. 9, Plate xxiv., which Mr. Olphert describes as a pipe picker. The broad part is about as thin as a worn sixpenny piece and is quite flat and without an edge at any part. All these objects were found over an extent of about eighty acres of sand. The bronze pins and brooches are beautifully patinated, and the majority of them are highly ornamented. Some, as figs. 3, 6, 7, and 9, in Plate xxiv., are made of white-metal, which I was informed by a jeweller was not silver. It patinates like bronze, and therefore I suppose it must be the white bronze which is called findruine. The pins and other articles were not found by Mr. Olphert himself; they were picked up on various occasions by his tenants and workmen, who brought them to him, and he either purchased them or gave the finder a small reward.

Mr. Olphert took me to the beach where all these objects had been procured, which I found to be a large extent of bare sand studded in places with hut-sites similar to those on other sandhills I have described. There were the usual hearths with black matter underneath, full of shells and rounded and broken quartzite pebbles, some of which were cracked from having been in the fire, but others were not burned, and had evidently been split into sharp-edged pieces by hammering. Those quartzite flakes and spalls must have been intentionally made, and used for cutting and scraping, though there was no evidence of dressing such as we find on flint implements. I picked up two flint pebbles which were split or chipped, but I saw no flakes or implements of that material. Some hammer-stones were found, the best of which I gave to Mr. Olphert, as such implements had not previously attracted his

attention. I turned over the contents of one hearth, but observed no pins or other metallic object. The shells, as in the other stations, were chiefly Patella, Littorina, Cardium, Mytilus, and Ostrea. The mussels were of large size; and Mrs. Kettlewell said that shells of that species were not now found in Ballyness Bay. Mr. Olphert informed me that the large extent of sandy beach which I saw, and over which the objects were found, had all within his own recollection been covered with sandhills thirty feet high.

Killala, Co. Mayo.

I was at Killala in 1889, and again in 1890. I have failed as yet to find any remains in the island of Fintragh, where there is a large extent of sandhills; but in Ross, which lies opposite to it in the County of Mayo, I found numerous hut-sites, from which, as at Ballyness, the sandy covering cannot have been long removed. The black layer, with sea-shells and broken pebbles, was well developed, but I did not obtain any flint or pottery. The pebbles were of hard, metamorphic kinds, and were split in the same manner as those at Bunbeg and Ballyness. I believe these were also used as implements. I got some small black flakes, but the material was not chert. Bulbs of percussion were visible, though the fracture was rough. Evidently any hard pebble was split up for cutting or scraping. I procured some hammerstones, one of which, in addition to being abraded at the ends, had a hollowed spot in the centre of one side from having been used as an anvil-stone. The large spalls were similar to those at Bunbeg, the natural outside surface giving a bevelled edge suitable for cutting. I found the greater part of a human skeleton lying across a hearth, but the skull was gone. From the way it was associated with the old floor, I would suspect it to be the skeleton of a person who had died in the hut, and been allowed to remain there. In the absence of the skull, I brought away the bones of one leg and an arm-bone. It will be observed from Mr. Newton's report on the bones that they belonged to a person strong and muscular, and that the tibia is platycnemic.

Whitepark Bay, Co. Antrim.

Several days were spent here, digging over part of the old surface. Everything lying upon it was cleared away, and the remains in the layer were carefully collected. A space of about 80 square feet, averaging 6 inches in thickness, was dug over; and when the objects

procured from it were counted, there were found to be two rude arrow or spear-heads, shown in Pl. XXIII., figs. 11 and 12; 21 scrapers and other dressed implements, all of which, with the exception of three or four poor duplicates, are figured in Pls. XXII. and XXIII.; 44 cores, 277 flakes and 13 hammer-stones; also a few pieces of hæmatite which had been scraped or rubbed; 14 pieces of plain and 4 pieces of ornamented pottery. In addition to these there was a coarse implement of deer's horn, rudely pointed, which is figured as No. 17, Plate XXIII. It was perfect when found, but was so soft that the point was accidentally broken or rubbed off. There were also bones and teeth of various animals, and sea-shells; but these latter were very fragile and easily broken. With the exception of the shells and about 100 of the poorest class of flakes everything found in the layer was brought away. In the British Museum there is exhibited a piece of the old floor of the dwellers in the Rock Shelters of the Dordogne, with the implements, flakes, bones, and other remains in their original position. It is a very instructive object-lesson. The floor at Whitepark Bay is not cemented together, and therefore a block of it, like that from the Rock Shelters, cannot be brought away; but I believe that the implements, cores, flakes, hammer-stones, pottery, teeth, and bones, as excavated from the old surface, laid out together for inspection, would give a better idea of the old surface layer at Whitepark Bay than any description could do. The bones are broken and split, but they are so fragile that they could not be extracted without further breakages. I believe, however, that there will be no difficulty in distinguishing between the old fractured edges and the newer ones caused by digging. The implements are of a coarse and rather peculiar nature. The number of side scrapers, as compared with the commoner kinds, is considerable. Fig. 10 is almost pointed, but the point is dressed as a scraper; figs. 2 and 7, Plate XXII., are axe-like; fig. 3, in same Plate, has no dressing except the teething on the edge, and has likely been used as a saw. One piece of pottery is figured to show ornamentation (see fig. 15, Plate XXIII.). The flakes are very poor and unshapely; but this may arise from the best having been previously selected for scrapers and other implements. I had the bones which were extracted, along with the implements and other objects described above, examined by Mr. E. T. Newton, F.G.S., F.Z.S., Palæontologist of the Geological Survey, London; and he found they belonged to *Bos longifrons*, *Cervus elaphus*, sheep or goat, pig, fox, the great auk, small form of goose, small gull and cod. There were also some bovine teeth, which seemed to be large for the long-faced ox.

Though no remains of dog were found in the digging described, still teeth of dog or wolf from previous diggings were determined by the late Professor A. Leith Adams. Several bones showed evidence of gnawing, but as to the question of whether any of the animals were domesticated I have not a decided opinion on the point. It appears to me that among the bovine bones the same parts are wanting that are absent in the case of the animals which were undoubtedly wild.

Grangemore, Co. Londonderry.

Since last Report was published the Rev. Leonard Hassé, M.R.I.A., has drawn attention to "iron slag" which is found in several hollows of the sandhills.[1] He submitted some of this material to Professor Harold B. Dixon, of Owens' College, Manchester, who pronounced it to be similar to slag "formed in the primitive reducing furnaces at present used in Africa," from which Mr. Hassé concludes that we have to deal with a primitive manufactory of iron, and that the nails and other pieces of iron lying about in the pits "are rejects imperfectly made or finished, and thrown away as of no further use." Supposing that the sandhills were a suitable site, there would be nothing remarkable in finding the remains of an iron manufactory so near the mouth of the Bann, without connecting it in any way with the flint implements; but I believe the evidence does not warrant the conclusion that an iron industry had been carried on here. The drops and lumps of "slag" or smelted iron are not found in one place, as might be expected if a manufactory had existed, but are scattered about in the pits, to use Mr. Hassé's words, "in a disorderly manner, such as the force of the winds could not explain." The swampy ground alongside the Bann, on which the Grangemore sandhills rest, shows evidence of bog-iron ore by the froth and scum on the water of drains, and the sands are also very ferruginous. Cakes of iron ore like the pan that forms in some kinds of cultivated ground are found in several places near the surface. Frequently also little pipe-like projections of iron ore are seen standing up, after wind or rain removes the loose sand. Seeing the ore lying about in this way, I believe we must attribute the origin of the slag to the fires of the prehistoric people. When fires would be placed on the sands containing these cakes and pipe-like projections, the ore would be smelted and the drops or lumps of so-

[1] Journal Royal Society of Antiquaries, Ireland, No. 2, vol. i., Fifth Series, page 130.

called "slag" would lie about among the sand, a few here and there, just as we find them at present. Grains of sand may be seen mixed with, and adhering to, the small lumps of smelted iron, which is most easily explained by supposing the smelting to have taken place in the accidental way I have suggested. In the primitive smelting furnaces in Africa the ore is placed in a hole in the ground previously heated, and fires are then put round it to smelt it and a channel is made to a hole at a lower level for collecting the molten matter. At Grangemore the smelting would be done in just such a primitive way as is carried on in Africa; but instead of collecting the smelted matter it was allowed to drop among the sands. It must be remembered also that the railway from Coleraine to Londonderry passes through the centre of the Grangemore sandhills, and that it is fenced on each side by a wire railing, the standards of which are soldered into stones. Pits lie close along each side of the railway; and many of the objects mentioned by Mr. Hassé in his paper were, I believe, distributed at the time the railway was being made. In many instances, where the iron objects are not rusted beyond all recognition, they show their modern character.

OTHER SITES.

At Fintragh, County Donegal, I found indications of a small settlement, as mentioned in the introduction. The sandhills had been previously cultivated, and are now covered with grass, but I found amongst other indications two anvil-stones with a pitted mark on one side of each. Near Cranfield Point, in County Down, I found low sandhills with cores and flakes. From finding at Bundoran chert-flakes and implements among the weathered carboniferous limestone, I examined the talus of weathered chalk along the Coast of Antrim, near Glenarm, and found flakes and cores. I also found in a field near the same place the site of a manufactory, and brought away cores, hammer-stones, and scrapers. I have been twice to Horn Head, near Dunfanaghy, since reading my last Report, and have each time examined the hut-sites there. I found several good examples of hammer-stones, a very perfect bone pin, pieces of pottery, and many pieces of split crystalline rock which I believe had been used in cutting and scraping. I also learned from a person living in Horn Head that not many years ago the hut-sites, which are now quite bare, were covered with high sandhills, which hid the view of the sea from the inhabitants living inland. I have been twice at Sligo in the hope of finding chert implements, but as yet without success. Other sites

exist, no doubt, farther south than Killala; and more sites may yet be discovered along the portion of coast which I have examined. As it is, I have shown a chain of sixteen or seventeen sites, extending from near Dublin, round the eastern, northern, and western coasts, as far as Killala, all showing a similar mode of living among the former inhabitants, but each settlement of people or tribe using for implements, as far as we know at present, whatever kind of rock they found in their own neighbourhood.

The Pottery.

The pottery from the old surface is both plain and ornamented, and all is undoubtedly domestic. Some Irish archæologists are of opinion that all ornamented pottery is sepulchral; and Canon Greenwell's authority is given in support of that view. No doubt some of the ornamented pottery found in barrows in England may, from its coarse and porous nature, be unfit for domestic purposes; but as other grave goods are found to be similar to those of everyday life, I do not see why the pottery should have been an exception. Very little pottery has been found in the British Isles that we can say was only used for domestic purposes; but Professor Boyd Dawkins, in his *Early Man in Britain*, page 268, gives an example of a hut-site of undoubted neolithic age in which ornamented pottery was found. If, however, we go to the Lake Dwellings of Switzerland, we find at Robenhausen, which is taken as the type of the neolithic age by eminent Continental authorities, and at Wangen, another typical Stone Age settlement, abundance of domestic pottery which is ornamented. It is probable that the forms, and also the ornamentation to a large extent, of the Bronze Age pottery had its origin in the Stone Age, and would be continued with slight modifications down to the Iron Age, and that many points of resemblance will be found in the pottery of one age to that of another. If burials in the Bronze Age took place in the sandhills of the seashore, as we find was the case in hills of sand inland, it is possible that the pottery of two distinct ages might after denudation of the sand containing it get mingled, and thus create confusion; but I see nothing in the pottery that is excavated from the old surface layer to cause doubts in anyone's mind as to its neolithic character. It is all hand-made, fairly strong, but not fine, and though in some cases the ornamentation is abundant, it is not very artistic.

The Black Layer or Old Surface.

The black layer is generally from four to six inches thick, but it may sometimes reach to ten or twelve inches. It is thickest in the

neighbourhood of hut-sites. Underneath hearths the black material is sometimes more than three feet in thickness. Sometimes several layers will be seen succeeding each other with layers of sand between. This occurs most frequently in the neighbourhood of hut-sites. I believe this succession of layers may have been occasioned by a few inches of sand that had accumulated on the surface in stormy weather, having been trampled down before it got time to blow off again. This new surface would become black in time like the one below it. At one part of Whitepark Bay, at Horn Head, and some other stations, the old surface and hearths are full of sea-shells; but where the implements and other stone objects are plentiful, as at other parts of Whitepark Bay, the shells are only sparingly distributed through the layer. At Dundrum sandhills, where sections forty to fifty feet in thickness may be seen, succeeding layers are sometimes several feet apart. In such cases I have generally found the upper layer to be more or less barren as compared with the lower one.

BRONZE PINS AND OBJECTS OF LATE AGE.

The finding of bronze pins and other objects of late age on the surface of some of the sandhills was referred to in my last Report. We can account for their presence in some such way as we would explain that of various articles belonging to the present day, which we occasionally find among the sandhills. During my visits in the past summer I have noted, from Grangemore, pieces of common clay pipes and fragments of ordinary cups and saucers. From Dundrum several pieces of a dinner plate; Bundoran, broken bottle glass; Horn Head, the iron shod of a labourer's shoe; and from the centre of a hearth at Killala a brass button. Some of these may have been carried and dropped by children, or have been accidentally lost in some cases by the owner while passing over the hills. In some such way I should say the bronze pins and coins found their way among the sandhills. With reference to the large quantity of pins, brooches, and other articles, which Mr. Olphert procured from Ballyness, the writer in the *Ulster Journal of Archæology*, seeing that the various articles which he enumerates are widely different in point of age, tries to explain the matter by showing that the place where they were found was near the pier at Ballyness Bay, which was the only safe landing-place for boats sailing between Tory Island and the mainland. He refers to the sacred character of the ecclesiastical establishment on the Island, and has no doubt that all visitors to it would embark at Ballyness Bay, and as at the present

time might be detained days, and perhaps weeks, before a safe passage could be effected. It is possible the articles may have been lost or dropped at different levels during the time the thirty feet of sandy covering was accumulating, and that all came to one level when the sand was blown away.

The difference in position between objects of neolithic and later ages is well shown in Professor Boyd Dawkins' work, "Cave Hunting." In a section given at page 87 of that work we see, in descending order, a layer consisting of two feet of talus, then a Romano-Celtic or Brit.-Welsh stratum, containing safety-pin brooches, spindle whorls, glass beads, brooches with enamel, buckles, bronze pin—in fact, a series not unlike those figured on Plate xxiv., from Mr. Olphert's collection. Then there comes six feet of talus separating the Brit.-Welsh stratum from one containing neolithic implements. The objects of different ages are found in their respective positions, owing to the cohesiveness of the formation; but if the whole mass was of sand and exposed to the weather, the objects of Brit.-Welsh and neolithic ages would soon be mingling together, and we would find a variety of opinions among explorers regarding the age of the mixed objects similar to that which we see respecting the finds from our own sandhills. If we could find some of those later objects at a higher level in the sandhills than the neolithic layer it would be more convincing, but it would be impossible to remove the thousands of tons of sand that cover the black layer in many places in the hope of finding a bronze pin or glass bead *in situ*. Metallic objects have never been found in the old surface, or in any way associated with the stone implements, except where they are brought into contact by means of denudation; but independent of this, the bronze and other objects of late date which are found on some of the sandhills are not a representative series of any period, but in the matter of age differ widely among themselves.

Conclusion.

The remains from the old surface layer are of purely neolithic character, and correspond to similar objects of that age in other parts of the British Isles and Europe. The number of flint implements which have been found in the various sandhills is large, and if flakes had been taken into account the total would have been enormous. Hitherto flakes have not been collected or enumerated; but from the diggings which I recently made at Whitepark Bay I found there were about 12 flakes to one dressed object, which I consider is much under

the average of flakes to dressed objects previously found; but, calculating on this basis, it would give an estimated total of about 30,000 objects, including flakes from Whitepark Bay alone, and yet we have doubts expressed as to there being a Stone Age in Ireland. Two poor but ordinary stone axes were found with the flints at Whitepark Bay, which were the only objects showing any trace of polishing. While satisfied as to the age of the remains from the sandhills, I feel that the neolithic period must have been of long duration, and that considerable development must have taken place during its continuance. I am therefore interested in the question as to whether the remains from our Irish sandhills occupy an early or late position in that age, and also as to the relation of the Stone Age in Ireland to that of other countries of Europe. It is probable that the northern and central portions of Europe were depopulated for a long time during the glacial period, which would account for the *hiatus* between the palæolithic and neolithic ages, but the inhabitants may only have been driven southwards till the glaciers passed away and the climate improved. The British Isles and the depopulated parts of Europe would then begin to be repeopled, and with this event would commence, I should say, the neolithic age. If the first neolithic people had come from the eastward there is no doubt that they would have been longest of reaching Ireland, as it lies farthest to the west. In that case the Stone Age in Ireland might have been more recent than the same age in other parts of Europe; but I believe it is more likely that the first neolithic people came northwards along the coasts, and that they were the descendants of or related to the palæolithic inhabitants who had been driven southwards, as we find many customs and forms of implements of the palæolithic age still surviving among the neolithic people. It is probable that, at the beginning of the neolithic age, the present conditions of climate, at least relatively, would have set in, that is that the isothermal lines would have occupied positions on a map somewhat corresponding with those of the present day. Ireland, as compared with the rest of Europe, would have a favourable climate, and there is no reason why the first neolithic people should be any longer in reaching the coast of Ireland than they would be in arriving at the shores of the Baltic. There are kitchen middens in Portugal, and also at various parts along the coast of France, as well as in Denmark. Our old surfaces in the sandhills, with their shells, broken bones, and implements, are really kitchen middens, and of the same nature as those of the Continent. The fauna of the sandhills is wonderfully in line with that of the kitchen middens of Denmark, and the finding of the Great Auk, which is now extinct

in Europe, among the Irish remains, makes the likeness more complete.

I am forcibly struck with the likeness of the implements from our own sandhills, which is shown more clearly by the illustrations accompanying last Report, to those of the Danish kitchen middens, and with the dissimilarity between the better class of implements in the two countries. This is most easily explained by supposing that, at an early stage of the newer stone period, the implements and habits of life, were similar over a wide area, and that as time went on the implements of the separate countries, perhaps by the ordinary process of development, acquired different forms. Possibly many early kitchen middens have disappeared owing to denudation along the various coasts, but those that are still available are now receiving the attention they deserve. I would hardly go the length of saying that the kitchen middens form an age by themselves but I believe they are among the earliest remains which we possess of the neolithic age.

Notes on Bones from the Kitchen Middens of Mayo and coast of Antrim, sent by Mr. W. J. Knowles. By E. T. Newton, Esq., Palæontologist to the Geological Survey.

Killala.

Homo.—The human bones comprise a femur, tibia, and ulna, all showing strongly-developed muscular attachments. The femur is 0·434 m. long (17·1 in.), and its least circumference 0·083, giving perimetral index of ·191. The upper three inches is more flattened than usual, being 0·033 in. wide and 0·022 in. thick.

The tibia is 0·362 m. long and at the lower end of the popliteal line is 0·0215 wide and 0·0335 deep, showing a decidedly platycnemic condition. The transverse section is triangular, the hinder part of tibia being flattened.

Whitepark Bay.

Bos longifrons.—A number of small bovine bones and teeth are referred to this species, as well as the milk-teeth of two calves. There are also some larger bovine teeth which seem too large for the long-faced ox.

Cervus elaphus.—To this species belongs a stout tibia, and perhaps a foot-bone.

Sheep or Goat.—Two lower jaw rami belong to one or other of these species.

Sus scrofa.—The pig is represented by portions of upper and lower jaws with teeth, and also a foot-bone.

Canis vulpes.—A portion of a lower jaw with two teeth, agrees with the same part of a fox.

Alca impennis.—Two humeri, undoubtedly belonging to this species.

Small form of goose.—A humerus and ulna, agreeing with those of the common goose in form, but much smaller in size.

Small gull.—A well-preserved humerus agreeing with that of a small gull.

Gadus morrhua.—An anterior caudal vertebra of a large codfish.

XLIX.

ON A MANNER OF LIGHTING HOUSES IN OLD TIMES, ILLUSTRATED BY RUSH-LIGHT CANDLESTICKS. BY REV. J. F. M. FFRENCH, F.R.S.A. (Ireland).

[Read JANUARY 12, 1891.]

As long as houses in Ireland were round, and had no lofts or partitions, they were probably illuminated in summer by the light that came through the door, and in winter by the fire that was kindled in the centre of the floor; but as soon as houses were constructed of an oblong shape, and when fires were removed to one end or side of the house, and a separate exit or flue provided for smoke, and lofts and partitions were introduced, then the necessity for a household illuminant must have been quickly felt; and as we might have expected, we find very early mention of such lights. It is stated by Dr. Sullivan, in his introduction to the "Manners and Customs," "that one of the essential articles of furniture in the house of a Bó-Aire was a candle upon a candlestick," it being the custom that in such abodes a light should be kept burning through the night. Sullivan also tells us that an oblong house was divided roughly, in the direction of its length, into three parts by two rows of pillars, which supported the roof, the candelabrum being placed between the fire and the door, and generally towards the middle of the house. Although references to candles and candlesticks are plentiful enough, yet detailed information as to the manner in which the candlesticks were constructed, or the material of which the candles were made, is as far as I know very rare. No doubt the wax of the large quantity of honey that was paid "as rents and tributes to the Kings and other Flaths" was utilized by them for lighting purposes; and in a legend recorded in one of the early Journals of the Kilkenny Archæological Society, mention is made of a square wax candle, which if square must have been run in a mould.

Doubtless also bog-wood was used as a torch for lighting purposes; for, down to our own time, long strips of bog-wood were dried, and made use of by the poorer classes instead of candles, and were placed

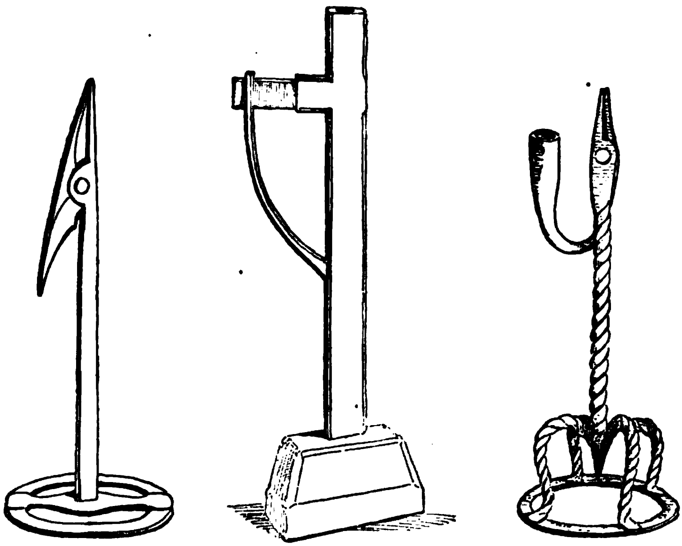
by them in candlesticks. But the method of household illumination which I would seek to bring under the notice of the Academy, is neither that of the very rich or of the very poor but the ordinary common manner of lighting houses, which, I believe, has come down to us from times that are prehistoric, and like the quern or hand-mill may be found in a few isolated instances still in use. The conservative Celt did not readily give up the use of his quern hand-mill, and even yet makes use of the rush-light. The candles that were used for ordinary lighting purposes seem to have been of three kinds: the dipped candle, which was made by taking a wick of flax, and dipping it again and again into melted grease until it had attained the necessary thickness; rushes may also have been used for wicks in this kind of candle; secondly, the rush-light candle, or rush taper, which was the light in every-day use; and, thirdly, the resin candle, called a snob, which was made by rolling resin in a soft state around a wick of linen rag. Just as the arrangements of Irish houses were in most respects similar to those of the Anglo-Saxons, so I believe were the methods of household illumination common to both. My attention was first called to Irish rush-light candlesticks by an engraving of an English candlestick that was exhibited in the collection of an English antiquarian, which I saw in one of the illustrated journals. I subsequently purchased one exactly similar to that engraving at a farm-house in my neighbourhood. Afterwards I saw a second illustration of another type of these candlesticks in that journal; and I also found one similar to it in another farm-house. I may mention that the English writer altogether misunderstood his candlestick, as he believed the pincers arrangement to hold the rush-light taper to be a kind of snuffers to snuff the candle, which was placed in the candle-holder.

The earliest mention I have been able to find of the preparation of rushes for lighting purposes is in a pretty story in the life of Cormac Mac [Art, King of Ireland, about the year A. D. 200 or 227. This story, as related by Keating and others, tells us that Cormac, riding through a wood, came suddenly and unobserved upon a fair damsel, who was engaged in her household avocations of milking and drawing water, and cutting rushes with a sharp hook; and as she cut the rushes she separated those that were long and green from such as were short and withered, and laid them in different heaps (the long green ones being, as we know, suitable for lighting purposes, and the others in accordance with the custom of the times for strewing the floor). One version of the story tells us that, when he revealed himself to her,

and questioned her about cutting the rushes, she told him that it was the work of the women to cut and peel the rushes, as women are the light of the house. The story further goes on to tell how, captivated by her beauty and her aptitude for housekeeping, he made her his Queen. Our story very plainly describes the first process in the manufacture of rush-lights: the cutting of long green rushes, and peeling them until nothing remained of the outside rind except a narrow strip of green just sufficient to bind together the pith. The rushes when thus prepared and dried were dipped into a vessel called a grisset, containing melted grease, and then dried. The grisset, of which I exhibit a miniature specimen, was a boat-shaped vessel of metal or iron, standing on three legs, and having a long handle projecting from the centre of the side. There were also long, narrow baskets, made for holding the prepared rushes, which were much prized, and considered suitable for wedding presents. The preparing and peeling of rushes was part of the work of every farmer's wife, almost to our own time; and the preparing and selling of bundles of rushes to old bachelors, and other unfortunates who had no women in their families to do the work, was a regular industry among the poor.

Now, with regard to the candlesticks or stands which held these rush-lights, they were very diverse in pattern; yet I think we can trace, not only distinct types, but also a steady progress in type in their manufacture. At first, I have no doubt that they were made of wood, and displayed but little refinement of art, although they showed a ready wit in the manner of their construction. I have had descriptions given me, or sent to me from different parts of Ireland, of these early and rude candlesticks. One such description was given me by a county Carlow man over eighty years of age, of a candlestick which was of a type that was old when he was young, and may well be a survival of the primitive pattern. He described this candle-holder as a round or square oak stick of the size of an ordinary spade-handle, or somewhat thicker, inserted in a block of wood: its height depending on whether it was to stand on the floor or on a table. If it was to stand on the floor, it would be about three feet long; if to stand on a table, it would be about ten or eleven inches in height. This upright post was bored in the centre to contain a candle, and had inserted in it, at right angles, a small piece of wood with a notch cut in it to hold a rush-light. The rush-light when inserted in the notch was kept in position by a wooden spring attached to the upright shaft, which sprang back against the notched hollow in the projecting shaft, and thus prevented the rush from dropping out. I had a model made of this type of candlestick

under his guidance and direction, which I exhibit (fig. 2), and which he says is exactly similar to the candlesticks that he remembers in use. I have obtained from the County Meath a similar description of a candlestick, except that instead of the rush being held in the notch by a spring, a wooden pincers was attached by a wooden dowel to the upright shaft. There is also a record of a rush-light candlestick seen in the County Sligo in the year 1760. It is described as two feet six inches high, with a stand of three legs and a catch to hold the rush-light. It must have been a candlestick such as one of these which the Hon. Emily



Lawless describes as having been found under sixteen feet of peat in a Kerry bog, the material of which it was composed being all wood. I now pass on to the iron forms of the rush-light candlestick, which plainly show the influence of the wooden forms which preceded them.

The first iron candlestick which I exhibit has a twisted iron stem, standing on three bowed and twisted iron supports, which are combined by an iron ring. It is fourteen and a-half inches in gross height; and the ring on which it stands is nearly five inches in width. It has a pincers arrangement at right angles with the shaft, the idea of which is plainly derived from the old wooden form; and it has also attached to it a place on which to stick a candle, which is what may be properly

called a *candlestick*, not a candle-holder such as that to which we give that name.

I next exhibit a sketch of a rush-light candlestick, in which an upright pincers has taken the place of the pincers at right angles with the shaft; but still the old wooden influence is shown in the spring which is adapted to keep the pincers closed (fig. 1). It is ten and a-quarter inches in height and four inches wide at base.

Next I show a pincers candlestick standing in a wooden block fourteen inches high and between four and five inches wide at base. This candlestick has no spring. Then a candlestick with a very nicely finished shaft of twisted iron, attached to an oak block or stand, with both a candle-holder and a rush-light holder. It stands fourteen and a-half inches high, and four and a-half inches wide at base.

Next I put forward a very well-finished rush-light and ordinary candle-holder combined, with twisted stem, and standing on four bowed and twisted legs united by an iron ring. It is twelve inches high and five inches wide at base (fig. 3). Then a much simpler candlestick of the same pattern, but not twisted, nine and a-half inches in height and four inches wide at base. I also exhibit a rush-light candlestick of iron, for standing on the floor, which I have removed from the block in which it was inserted in order to enable me to carry it more easily. At present it is two feet seven and a-half inches in height, with a twisted stem. When inserted in its block it stood three feet high. In conclusion, may I say that in these days of progress, when the electric light may be seen under the shadow of Mount Leinster, and when even a pair of snuffers is an unknown implement to which no name could be be attached by many of our young people, it may not be undesirable to preserve some record of a method of household illumination that is now very much a thing of the past.

L.

NOTES ON NEWTONIAN CHEMISTRY. By REV. SAMUEL HAUGHTON, M.D., President of the Academy.

[Read May 12, 1890.]

Note I.—Binary Compounds.

(*Hydrochloric Acid Type.*)

By the term "Newtonian Chemistry," I mean the hypothesis that atoms of the chemical elements in acting upon each other obey the Newtonian laws of gravitation, with this difference, that whereas the specific coefficient of gravity is the same for all bodies, independent of the particular kind of matter of which they are composed, the atoms have specific coefficients of attraction which vary with the nature of the atoms concerned.

Thus, the attraction of two atoms for each other is expressed by the equation

$$\text{attraction} = \mu \frac{mm'}{r^2},$$

where m, m' are the masses of the atoms, r their mutual distance, and μ their specific coefficient of attraction.

Professor Mendelejeff, in a lecture delivered at the Royal Institution of Great Britain, May 31, 1889, popularised[1] this method of viewing Chemistry by comparing binary compounds to systems of double stars in a condition of steady motion, such as HF, HCl, HBr, HI, HH, ClCl, BrBr, &c. &c. Ternary compounds, such as

[1] Mendelejeff says: "Of Newton's three laws of motion, only the third can be applied directly to chemical molecules when regarded as systems of atoms among which it must be supposed that there exist common influences or forces, and resulting compounded relative motions."

This is not correct, for it is as easy to apply the first and second laws as the third, and to add on the principle of gravitation. Moreover, Mendelejeff's method of dealing with the Law of Equality of Action and Reaction, is open to Dynamical objections of a serious kind.

HOH, ClOCl, HOCl, &c., he compares to planets with two satellites; quaternary compounds, such as H_3N, he regards as planets with three satellites; quinary compounds, such as H_4C, are planets with four satellites, and so on.

It is my intention, in these notes, to follow up Newtonian principles to their legitimate consequences in certain well-established chemical combinations, and to test the conclusions to which they lead with well-known chemical facts; if, in the course of these calculations, we are led to conclusions at variance with chemical facts, then the hypothesis of Newtonian Chemistry must be set aside, and some other mode of motion, better fitted to explain the facts, be adopted.

Binary compounds are molecules consisting each of two atoms, which may be the same or different, such as

HH, ClCl, HCl, HI, &c.

Of these, I shall discuss in the first place, HH, ClCl, HCl, as their chemical and physical properties are well established:—

1. *The Hydrogen Molecule.*—This I represent by two atoms of hydrogen revolving uniformly in a circle round C, their common centre of gravity.

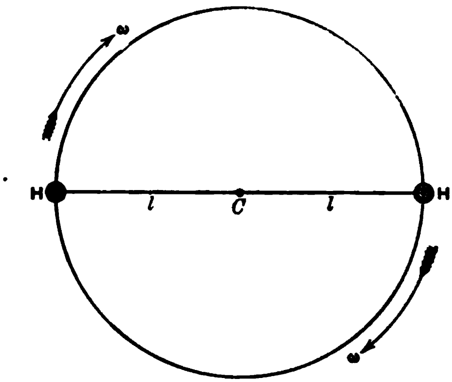


Fig. 1.

If μ denote the coefficient of attraction, at unit distance, for unit masses of hydrogen, l the radius of the orbit, a the mass of

the hydrogen atom, and ω the angular velocity of the orbital motion, then we have

$$\text{attraction} \qquad = \mu \frac{a^2}{(2l)^2};$$

$$\text{centrifugal force} = \omega^2 l a.$$

Equating these, we find—

$$\mu = \frac{4 l^3 \omega^2}{a}. \qquad (1)$$

2. *The Chlorine Molecule.*—The type of the Chlorine Molecule is the same as that of the Hydrogen Molecule, with the exception

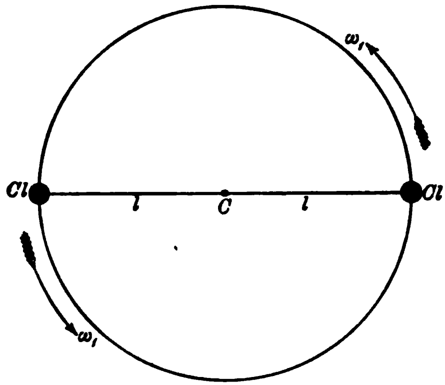


FIG. 2.

that the orbital motion is reversed.[1]

If now,

μ_1 = attraction coefficient of ClCl,

l = radius of chlorine molecule orbit,

ω_1 = angular velocity of chlorine molecule orbit,

β = mass of chlorine;

then,

$$\mu_1 = \frac{4 l^3 \omega_1^2}{\beta}. \qquad (2)$$

3. *The Molecule of Hydrochloric Acid.*—The type of the HCl molecule is different from that of the HH and ClCl molecules, because the masses of the atoms are unequal.

[1] The reason why this is necessary will be shown further on.

Let C be the common centre of gravity of the atoms H and Cl, and let two circles with radii CH = l and CCl = m be described;

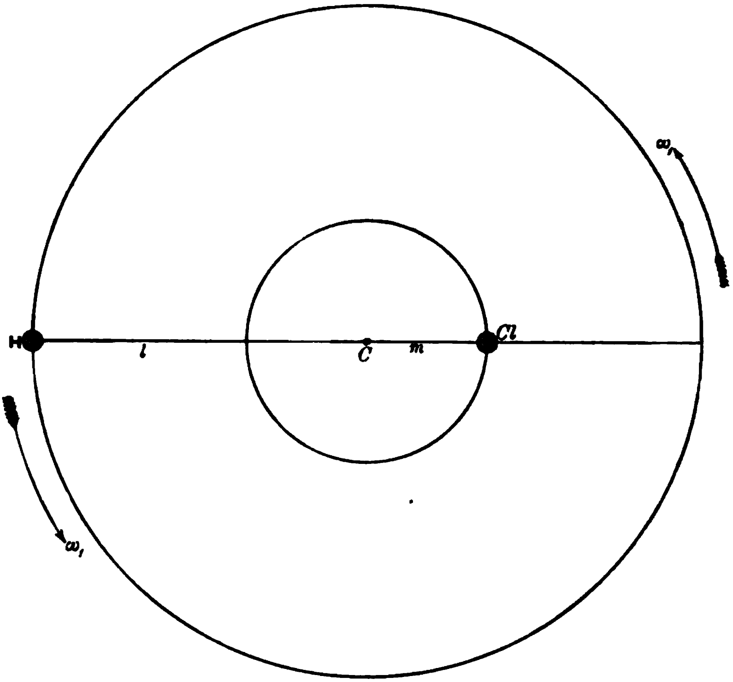


Fig. 3.

the atoms revolve in these two circles with the same angular velocity.

Let

α = mass of hydrogen atom,

β = mass of chlorine atom,

μ' = attraction of hydrogen for chlorine, for unit distance and unit mass,

ω' = angular velocity of orbital motion.

Equating the attraction to the centrifugal force of H and Cl, we find

$$\omega'^2 l = \frac{\mu' \beta}{(l+m)^2},$$

$$\omega'^2 m = \frac{\mu' \alpha}{(l+m)^2};$$

adding together, we find

$$\mu' = \frac{(l+m)^3}{\alpha+\beta}\omega'^2;$$

but, since C is the centre of gravity, l, m are inversely as α, β; therefore

$$l + m = l\left(\frac{\alpha+\beta}{\beta}\right);$$

and

$$\mu' = l^3\frac{(\alpha+\beta)^2}{\beta^3}\omega'^2. \tag{3}$$

The molecular volume of a gas is measured by atomic weight divided by specific gravity, and the molecular volumes of hydrogen and chlorine, determined by the best experiments, are found to be.

Molecular Volume.

$$\text{Hydrogen} = \frac{2 \times 1}{0{\cdot}06926} = 28{\cdot}88;$$

$$\text{Chlorine} = \frac{2 \times 35{\cdot}5}{2{\cdot}45} = 28{\cdot}89;$$

and the molecular volume of hydrochloric acid is known to be the same, by a comparison of its molecular weight with specific gravity: or, in other words, the number of molecules of hydrogen, of chlorine, or of hydrochloric acid, in a given volume, is the same, at equal pressures and temperatures.

We must now define our units of space, time, and mass.

I take for unit of space the radius of the orbital circle of the hydrogen or chlorine molecule, which must be equal to the radius of the orbit of hydrogen, in the hydrochloric acid molecule.

The unit of time is defined by making $\omega = 1$ in the hydrogen molecule motion, and the unit of mass is given by making $\alpha = 1$, which is the atomic weight of hydrogen. Equations (1), (2), (3) thus become

$$\mu = 4. \tag{1$'$}$$

$$\mu_1 = \frac{4\omega_1^2}{\beta}. \tag{2$'$}$$

$$\mu' = \frac{(\beta+1)^2}{\beta^3}\omega'^2. \tag{3$'$}$$

These equations enable us to eliminate the troublesome coefficients of attraction, and to replace them by the elegant and easily conceived geometrical ideas of angular velocity or periodic time.

By making β equal to the atomic weight of fluorine, chlorine, bromine, and iodine, we obtain the conditions belonging to hydrofluoric, hydrochloric, hydrobromic, and hydriodic acids respectively.

4. *Formation of Hydrochloric Acid from Hydrogen and Chlorine.*—Hydrogen and chlorine, when mixed together in the proportion necessary to form hydrochloric acid, do not combine in the dark, but do so explosively when exposed to sunlight, especially to the violet rays, or when exposed to the electric or magnesium light. They also combine when heated to a temperature of 150°, and the hydrochloric acid decomposes again into hydrogen and chlorine when heated to a temperature of 1500°.

When two molecules of chlorine and hydrogen combine they form two molecules of hydrochloric acid, and are subject during the transformation to two dynamical laws.

(*a*) The conservation of areas.

(*b*) The Law of Energy or *vis viva*. No matter what happens during the collision, the sum of the areas (*moment of momenta*) remains constant, and the total energy of the system before and after the shock differs by a quantity that can be measured by experiment.

The conservation of areas gives the following:—Before the shock

$$\text{Hydrogen molecule} = 2\alpha l^2\omega.$$

$$\text{Chlorine molecule} = 2\beta l^2\omega_1.$$

After the shock—

$$2 \text{ Hydrochloric molecules} = 2\,(\alpha l^2 + \beta m^2)\,\omega'.$$

Equating these, we find

$$(\alpha\omega + \beta\omega_1)\,l^2 = (\alpha l^2 + \beta m^2)\,\omega';$$

or, making l, α, ω, equal unity, and $m = \dfrac{1}{\beta}$ we obtain finally from the conservation of areas

$$(\beta + 1)\,\omega' = \beta\,(1 + \beta\omega_1). \tag{4}$$

From the Law of Energy we find before collision—

$$\text{Energy of position} = \mu\,\frac{\alpha^2}{2l} + \mu_1\,\frac{\beta^2}{2l};$$

$$\text{Energy of motion} = -\,(\alpha\omega^2 + \beta\omega_1^2)\,l^2,$$

or, substituting for μ, μ_1, from equation (1)′, (2)′, and using the proper units—

$$\text{Energy of position} = 2\,(1 + \beta\omega_1^2).$$

$$\text{Energy of motion} \;\; = -\,(1 + \beta\omega_1^2).$$

$$\text{Total energy before collision} = (1 + \beta\omega_1^2).$$

After collision we have—

$$\text{Energy of position} = 2\mu' \frac{\alpha\beta}{l + m};$$

$$\text{Energy of motion} \;\; = -\,(\alpha l^2 + \beta m^2)\,\omega'^2;$$

or, introducing the proper units, and substituting for μ' from (3)′—

$$\text{Energy of position} = 2\,\frac{\beta + 1}{\beta}\,\omega'^2,$$

$$\text{Energy of motion} = -\,\frac{\beta + 1}{\beta}\,\omega'^2;$$

$$\text{or, total energy after collision} = \frac{\beta + 1}{\beta}\,\omega'^2;$$

$$\text{and finally, } \left\{1 + \beta\omega_1^2 - \frac{\beta + 1}{\beta}\,\omega'^2\right\} = \mathrm{A}, \qquad (5)$$

represents the loss or gain of energy, when a molecule of hydrogen and a molecule of chlorine combine to form two molecules of hydrochloric acid.

When one gram of hydrogen combines with 35½ grams of chlorine the quantity of heat given out is sufficient to raise 22,000 grams of water 1° C.[1] If, therefore, n^3 represent the number of molecules in one gram of hydrogen, the coefficient A, in equation (5) may be replaced as follows:—

$$\mathrm{A} = \frac{22000}{n^3},$$

because A represents the energy lost by one molecule of hydrogen combining with one molecule of chlorine. Equations (4) and (5) thus become

$$(\beta + 1)\,\omega' = \beta\,(1 + \beta\omega_1), \qquad (4)'$$

$$1 + \beta\omega_1^2 - \frac{\beta + 1}{\beta}\,\omega'^2 = \frac{22000}{n^3}, \qquad (5)'$$

---

[1] Thomsen.

where $\beta = 35\cdot5$, and ω', ω_1, n, are unknown. We have, therefore, two equations and three unknown quantities. If we eliminate ω_1 between the equations (4)′ and (5)′ we find, after some reductions

$$n^3\{(\beta^2-\beta-1)\omega'^2+2\beta\omega'-\beta^2\}+\frac{22000\,\beta^2}{(\beta+1)}=0. \qquad (6)$$

This equation becomes numerically

$$n^3\{1223\cdot75\omega'^2+71\omega'-1260\cdot25\}+\frac{22000\beta^2}{(\beta+1)}=0. \quad (6)'$$

As n^3 must be essentially positive the quadratic function of ω' must be essentially negative; now this quadratic has two real roots, viz.:—

$$\omega' \begin{cases} +\,0\cdot9862089 + \&c., \\ -\,1\cdot0442273 + \&c. \end{cases}$$

We can show, from chemical considerations, that $\omega'^2 > 1$, and therefore we must choose a negative value for $\omega' > 1 < 1\cdot0442273 + \&c.$ The attraction of the hydrogen atom for the chlorine atom in the hydrochloric molecule must be greater than that of the hydrogen atoms for each other in the hydrogen molecule or than that of the chlorine atoms for each other in the chlorine molecule. In the hydrochloric molecule the distance between the atoms is $1+\dfrac{1}{\beta}$ and in the hydrogen molecule the distance is 2; hence the attractions in the hydrochloric and hydrogen molecules are

$$\frac{\mu'\beta}{\left(1+\dfrac{1}{\beta}\right)^2} \text{ and } \frac{\mu}{4}.$$

Substituting in these the values of μ and μ' already given (1)′ and (2)′ the first reduces to ω'^2 and the second to unity; hence $\omega'^2 > 1$. Similar reasoning applied to the chlorine molecule gives the relation $\omega'^2 > \beta\omega_1^2$. It follows from all the preceding that the rotation of the chlorine and hydrochloric molecules is opposite to that of the hydrogen molecule; that the rotation of the hydrochloric molecule is comparable with that of the hydrogen molecule, and that they are both much more rapid than that of the chlorine molecule. The whole subject will be better understood by considering equation (6)′ as a cubic curve, whose coordinates are n^3 and ω'.

The general shape of the curve is shown in figure 4, where $+\omega'$, $-\omega'$ is the axis of x, and $+n^3$, $+n^3$, the axis of y. The axis of ω' is an asymptote, and there are two other asymptotes AB and CD parallel to the axis of y, and lying at distances from the origin $+a$ and $-b$ corresponding to the real roots of the quadratic in ω'.

There are three real branches of the curve, one lying between AB and O, ω'; the second between CD and O, $-\omega'$; and the third lying between AB, CD, and the axis of x. Of these branches the first two are to be rejected, because they correspond to negative values of n^3.

Of the remaining third branch of the cubic curve, the right-hand side corresponding to positive values of ω' must be rejected, because ω'^2 is never greater than unity, and the point of the curve which determines ω' must lie very high up on the left-hand branch, because n^3 must be an enormously great number.

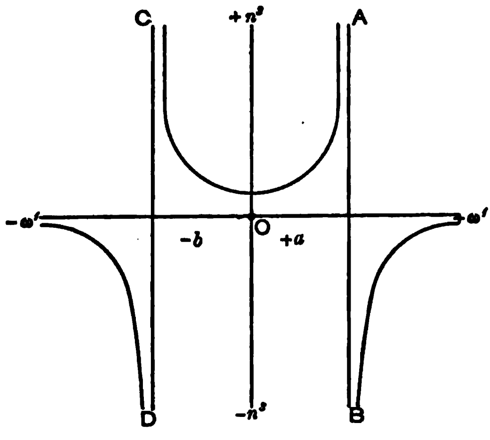


FIG. 4.

5. *Hydrofluoric Acid* (HF).—The probabilities are very strong that the molecular volumes of fluorine and hydrofluoric acid are the same as those of hydrogen, chlorine, and hydrochloric acid.

Assuming this to be the case, I proceed to determine the rotations of fluorine and hydrofluoric acid by means of equations (4)′ and (5)′, making $\beta = 19$ and writing for 22000 the constant 37600, which

represents the amount of heat lost when one gram of hydrogen combines with 19 grams of fluorine.[1]

We thus find

$$20\omega' = 19(1 + 19\omega_1). \qquad (4)'$$

$$1 + 19\omega_1^2 - \frac{20}{19}\omega'^2 = \frac{37600}{n^3}. \qquad (5)'$$

Eliminating ω_1 we obtain

$$n^3\{341\omega'^2 + 38\omega' - 361\} + \frac{37600 \times 6859}{20} = 0. \qquad (6)'$$

Hence we find

$$\text{asymptotes } \omega' \begin{cases} +\ 0{\cdot}9746966 + \&c. \\ -\ 1{\cdot}0861335 + \&c. \end{cases}$$

Reasoning similar to that used in the case of hydrochloric acid shows that

$$\omega'^2 > 1.$$

We must therefore, as before, choose a negative rotation exceeding unity and less than the asymptote.

6. *Hydrobromic Acid* (HBr).—The molecular volumes of bromine and hydrobromic acid are the same as those of hydrogen, chlorine, and hydrochloric acid.

$$\textit{Mol. Vol. Bromine} = \frac{2 \times 80}{5{\cdot}46} = 29{\cdot}304.$$

Equations (4)′ and (5)′ become, when $\beta = 80$,

$$81\omega' = 80(1 + 80\omega_1). \qquad (4)'$$

$$1 + 80\omega_1^2 - \frac{81}{80}\omega'^2 = \frac{8440^2}{n^3}. \qquad (5)'$$

Eliminating ω_1 we find

$$n^3\{6319\omega'^2 + 160\omega' - 6400\} + \frac{12100 \times 512000}{81} = 0. \qquad (6)'$$

Hence we find

$$\text{asymptotes} \begin{cases} +\ 0{\cdot}99380828 + \&c. \\ -\ 1{\cdot}01912873 + \&c. \end{cases}$$

But, as before, $\omega'^2 > 1$.

Therefore we must choose the negative rotation.

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[1] Berthelot and Moissan.

[2] Because 1 gram of hydrogen and 80 grams of bromine, assumed to be gaseous, in uniting, give off 12100 units of heat (Thomsen).

7. *Hydriodic Acid* (HI).—Iodine and hydriodic acid have the same molecular volume as all the preceding compounds.

$$\textit{Mol. Vol. Iodine} = \frac{2 \times 127}{8{\cdot}765} = 29{\cdot}98.$$

Equations (4)′ and (5)′ become, when $\beta = 127$.

$$128\omega' = 127\,(1 + 127\omega_1). \qquad (4)'$$

$$1 + 127\omega_1^2 - \frac{128}{127}\,\omega'^2 = -\frac{E^1}{n^3}. \qquad (5)'$$

Equation (6)′ becomes

$$n^3\{16001\omega'^2 + 254\omega' - 16129\} - \frac{E \times 2048383}{128} = 0. \qquad (6)'$$

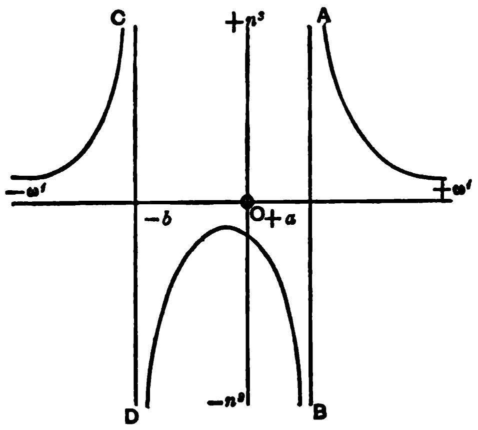

FIG. 5.

The change in sign of the absolute term changes the form of the curve, which now becomes fig. 5.

The branch of the curve lying between the asymptotes AB and CD lies altogether on the negative side of n^3, and is therefore to be rejected; and the quadratic function of ω' must be positive, so as to give a positive value for n^3, and the two branches of the curve with which we are concerned lie altogether outside the asymptotes AB and CD.

[1] When 1 gram of hydrogen combines with 127 grams of iodine, assumed to be gaseous, the thermal effect is very slight, some heat being *gained* during the operation; hence the negative sign. The quantity E is much less than 1540.

Solving the quadratic, we find the position of the two asymptotes, viz.:—

$$\omega' \begin{cases} +\ 0{\cdot}99608621 \quad + \text{\&c.} \\ -\ 1{\cdot}011960389 + \text{\&c.} \end{cases}$$

For the reasons already given

$$\omega'^2 > 1,$$

and as we must take points on the curve outside the asymptotes, it appears at first sight that we might have two real values of ω', one positive and one negative. This, however, is not the fact, for we can show that the negative value is the only one that will answer.

8. *General Conclusions respecting Binary Compounds.*—The two fundamental mechanical equations of binary compounds are (4) and (5), derived respectively from the Conservation of Areas, and the Loss or Gain of Energy during combination.

By eliminating ω_1 between these equations we find, in general, equation (6)

$$n^3\{(\beta^2 - \beta - 1)\,\omega'^2 + 2\beta\omega' - \beta^2\} \pm \frac{\beta^3}{\beta + 1} E = 0, \qquad (6)$$

in which $\pm E$ represents the loss or gain of energy (expressed in heat units) during combination. This equation, regarded as a curve of which n^3 and ω' are the Cartesian co-ordinates has been sufficiently discussed, and the available value of ω' shown to be negative and greater than unity.

It follows from this that the available value of ω_1 must be negative, and this value is found by eliminating ω' from the equations (4) and (5), from which I find

$$n^3\left\{(\beta^2 - \beta - 1)\,\omega_1^2 + 2\beta\omega_1 - \frac{1}{\beta}\right\} \pm \frac{\beta + 1}{\beta} E = 0. \qquad (7)$$

Now it is well-known from the discussion of the planetary perturbations that they become very serious whenever the periodic times of two or more planets or satellites have a small common multiple.

Following this guiding idea, and taking into consideration the intense affinity of hydrogen for fluorine and chlorine, I thought it highly probable that the ratios of the periodic times of fluorine, chlorine, bromine, and iodine to that of hydrogen, would turn out to be represented by fractions, with small integers for numerator and denominator, or perhaps even whole numbers.

I have shown that the value of ω_1 must be negative, and assuming

$$\omega_1 = -\frac{1}{m},$$

we transform equation (7) into the following:—

$$n^3\{\beta^3 - (2m+1)\beta^2 - \beta - m^2\} \pm (\beta + 1)m^2 E = 0. \qquad (7)'$$

As n^3 is a very large number compared with β, E, and m, this equation is nearly equivalent to

$$\beta^3 - (2m+1)\beta^2 - \beta - m^2 = 0. \qquad (8)$$

In this equation β is the atomic weight of one of the four elements under consideration, and m is the ratio of its molecular periodic time to the molecular periodic time of hydrogen; and a relation is thus established between β and m by which, if either be given, the other can be calculated.

If we assume the following values for the ratio of the periodic times of the four elements to that of hydrogen, we can readily calculate from equation (8) the values of the atomic weights.

	Ratio of Periodic Times.	Atomic Weight.		Diff.
		Calculated.	Observed.	
Hydrogen,. .	1	1·00	1·00	± 0·00
Fluorine, . .	9	19·27	19·00	+ 0·27
Chlorine, . .	17	35·25	35·50	− 0·25
Bromine, . .	39	79·25	80·00	− 0·75
Iodine, . .	63	127·25	127·00	+ 0·25

Chemists must decide whether these differences are or are not greater than they can allow in the atomic weights of the four elements in question.

In the preceding investigations I have used one hypothesis only, viz. that the atoms obey the same law of attraction as the heavenly

bodies, viz. the Newtonian law of the inverse square of the distance, and product of masses.

We can at once find the periodic times of the hydrofluoric, hydrochloric, hydrobromic, and hydriodic acid molecules from the foregoing:—

As I have assumed, $\omega_1 = -\frac{1}{m}$, equation (4), (conservation of areas) becomes, by transformation,

$$\omega' = -\frac{\beta}{\beta+1} \times \frac{\beta - m}{m}. \tag{9}$$

From this we find, using the corresponding values of m and β:—

Angular Velocity and Periodic Times.

	Angular Velocity.	Periodic Time.
HH	+ 1·00000	1·00000
HF	− 1·08482	0·92181
HCl	− 1·04490	0·95740
HBr	− 1·01919	0·98117
HI	− 1·01189	0·98825

From all the foregoing I draw the following general conclusions:—

1. That the hydrogen molecule will combine with the fluorine, chlorine, bromine, or iodine molecule only when their rotations have opposite directions.

2. That the rotation of the resultant molecule is opposite to that of hydrogen, and in the same direction as that of the second element.

3. That it is probable that the periodic times of the hydrogen, fluorine, chlorine, bromine, and iodine molecules are in the exact proportions of 1, 9, 17, 39, and 63.

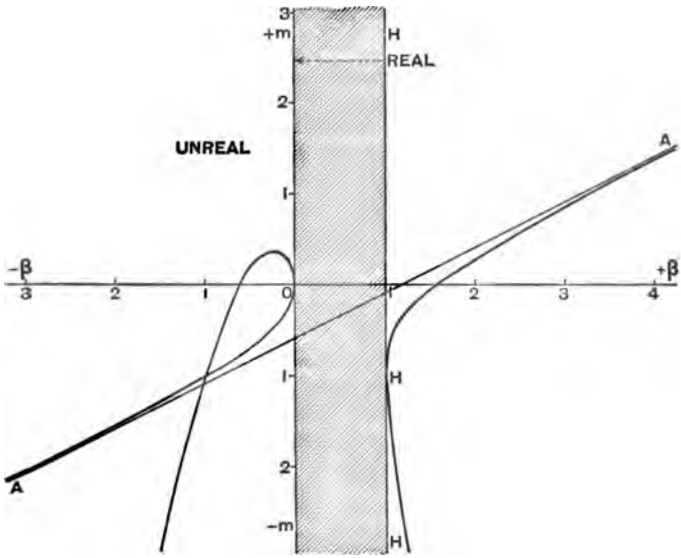

FIG. 6.

In Figure (6) I have exhibited the general form of equation

$$\beta^3 - (2m + 1)\beta^2 - \beta - m^2 = 0 \qquad (8)'$$

regarded as a curve showing the relation between atomic weight and periodic time of molecular rotation.

All to the right of the line *mOm* is real and corresponds to positive values of atomic weight, and all to the left of *mOm* is unreal and corresponds to negative values of atomic weight ("behind the looking-glass").

The curve has one real asymptote shown by the line AA, and two branches, one to the right which is real and hyperbolic, and one to the left which is unreal and nodal.

The real elements represented on the hyperbolic branch are hydrogen, fluorine, chlorine, bromine, and iodine; and hydrogen lies at the opposite side of the line $\beta O \beta$, because its rotation is opposite to that of the other named elements.

It is a remarkable fact that no portion whatever, real or unreal, of the curve, exists in the shaded space between the lines *mOm* and

HHH, that is to say, this curve excludes the possibility of any element, capable of combining with hydrogen, having a less atomic weight than that of hydrogen, including of course the so-called helium.

This appears to me to be a striking confirmation of Dr. Reynolds' contention that hydrogen is the last of a period of seven elements, and that the other six have no real existence.

The equation of the asymptote is

$$8m - 4\beta + 5 = 0. \tag{10}$$

LI.

A COMMENTARY ON THE COLLOQUIES OF GARCIA DE ORTA, ON THE SIMPLES, DRUGS, AND MEDICINAL SUBSTANCES OF INDIA. By V. BALL, C.B., LL.D., F.R.S., Director of the Science and Art Museum, Dublin.

[Read January 12, 1891.]

Part II.[1]—INTRODUCTORY.

As already stated the division of the Colloquies into two parts is only a matter of present convenience, having no existence in the original.

The contents of this Part equal, if they do not exceed, in interest and value those of the preceding Part. Both afford testimony of the vigour with which our author grappled with the myths and nostrums of his predecessors.

This commentary does not profess to be exhaustive of all that Garcia has written; to be so it would have had to deal with the ancient authors whom he criticises, and that would have involved an amount of labour and expenditure of time which I could not have devoted to the purpose. It will have to be undertaken, however, by whoever edits the work as a whole. For the present occasion it seems to be sufficient to identify, in the light of our modern knowledge, the subjects of the Colloquies, while at the same time drawing attention to the statements of Garcia which seem to be of particular value or interest.

The merits of his volume are undoubtedly very great, and the tacit or acknowledged use made of his facts by his successors affords ample testimony of the esteem in which he has been regarded by them as the highest authority of the period on the subjects of which he treats.

[1] *Vide* antea, page 415.

Contents of Colloquies xxxi.–lviii.

COLLOQUY XXXI.

DO PAO CHAMADO "CATE" DO VULGO; E DIZ-SE NELLE COUZAS PROVETIOSAS.

[Catechu, prepared from the wood of ***Acacia catechu***, Willd., and ***A. suma***, Kurz, trees which grow to from 30 to 40 feet high.]

Called ***cate*** (***katha***) in India, also by Arabs and Persians; ***cato*** in Malacca (Borneo ?); ***hac dudh*** by Avicena and Serapion. The tree is called ***hac chio*** in the land where it grows, and it is the ***licium*** of Galen and Pliny, so named because it was first found in Licia. The tree, says Garcia, is specially abundant in Cambay, also in the lands of Bassein, Manora, Mandwa, Damun, and on the mainland near Goa. The prepared catechu was, he says, exported in abundance to Malacca and China, to be eaten with betel, and was taken as a medicine to Arabia, Persia, and Khorassan. The wood, he adds, is strong and heavy, and is used for pestles and clubs for husking rice (this is the case still). He says the tree has flowers but no fruit (the fruit consists of pods).

The wood when cut from the tree was boiled,[1] and the preparation thus obtained was mixed with the flour of ***nachani*** (? ***ragi*** or ***murwá***, ***Elusine corocana***) and made into lozenges. He says it affords a very astringent and comforting medicine, good for fluxes and for pains in the eyes, and that it strengthens the gums and teeth, and kills the worm in them.

He shows the improbability of its being exported in bags of rhinoceros and camel skins, as Pliny had stated to be the case, by pointing out the rarity or absence of these animals in the countries where it is produced. He states that the rhinoceros was called ***gramdas***[2] (***gandá***), and that in Bengal the horn was used as an antidote to poison, and that the Nizam would give 200 times its weight in gold for true unicorn horn.

He judiciously adds that he does not altogether like to say what he has heard about the unicorn, because his informants were not themselves eye-witnesses of what they related; but admits that they said that it was to be found between the Capes of Corrientes and Good Hope,

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[1] I have frequently seen this process in operation. *See* "Jungle Life in India," p. 61.

[2] ***Gandas***, as quoted by Thomæ Bartholini, "de unicornu," Amsterdam, 1678, p. 157, &c.

that it had a head and mane like the sea-horse, with a flexible horn like a finger, and that it fought courageously with elephants. He relates how shavings of the horn saved the life of a dog poisoned with arsenic, while another dog which had taken half the amount of arsenic died. [The belief in the horn of the unicorn being an antidote to poison is still prevalent in India.]

[References.—*Linschoten*, II., pp. 65, 67; *Bontius and Piso*, lib. vi., cap. iii., p. 92, fig.; *Ainslie*, I., pp. 64, 65, and 590; *Fluckiger and Hanbury*, pp. 213; *Khory*, p. 260.]

COLLOQUY XXXII.

Da Maça e Noz.

[Of Mace and Nutmeg—the pericarp and nut of *Myristica fragrans*, Houtt.]

The mace and nut are called respectively *bunapalla* (*bunga-pala*) and *palla* (*pala*) in the Island of Banda; *jupatri* (*jaipatri*) and *jaifol* (*jaiphal*) in the Deccan; *besbase* (*basabasaha*) and *jausiband* and *geausi* (*jousa-bovah*) by Avicena and the Arabs, besides which there are many corrupt names used by Moors, Arabs, and Turks.

Garcia says that mace was unknown to Galen and Dioscorides as well as to other Greeks, and also to Pliny. That *macir* as described by Galen was not mace is certain from the medicinal qualities he ascribes to it, while Dioscorides said it was the rind of a root. Although Avicena and Serapion knew the mace and nutmeg, their accounts are not free from confusion owing to their having been implicit followers of the Greeks.[1] He says a preserve of mace made with sugar was pleasant to the taste and smell, and was considered good for the brain and for affections of the brain and nerves, and that mace in vinegar was imported in jars from Banda, and was eaten as a salad. He describes the beauty of the trees when laden with the bursting fruit, which causes the exposure of the red mace.

[References.—Mace *Piso* in *Mantissa aromatica*, p. 173, fig.; *Clusius* (*Acosta*), p. 23; *Linschoten*, II., pp. 84–86; *Ainslie*, I., p. 200; *Fluckiger and Hanbury*, p. 456; *Khory*, p. 468.]

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[1] *Fluckiger and Hanbury* ("Pharmacographia," p. 451) quote this opinion with approval from *Acosta*, but he merely adopted it from his predecessor, *Garcia de Orta*.

COLLOQUY XXXIII.

DA MANNA PURGATIVA, ONDE, SE FALLA D'OUTRAS MUITUS COUZAS, QUE SÃO MENOS MEDICINÆS, E SAO DE HISTORIA, E BOAS PERA AS SABEREM ALGUMAS PESSOAS.

[Of the purgative manna, in which (Colloquy) many other things are spoken of that are not medicinal, but are historical and suitable for some persons to know.]

[Manna is a saccharine exudation from the manna ash, *Fraxinus ornus*, L. It is found in Italy, Sicily, &c., extending to Asia Minor. It is also produced by various other trees.]

Garcia states that although he did not know much about its origin he knew of its good effects. Three kinds were, he says, brought from Hormuz, from the province of Usbeque (Tartary). One called *xirquest* or *xircast* (*shirkisht*) was a kind of dew or gum produced on *quest* trees; a second was called *tiriumjubim* or *trumgibim* (*taranjubin*), is produced on thorny shrubs, and is in small pieces of a colour between purple and red, a third arrives in large pieces by way of Bassora mixed with leaves, and resembles that of Calabria; still another kind reached Goa from Hormuz in leather bottles: it resembled congealed honey.

[Ainslie has some interesting remarks on the different plants which produce Manna. He attributes its formation in the natural condition to the action of some species of *Coccus* (?); artificially it is produced by incisions on the stems of the plants which yield it.]

Linschoten's remarks on this subject, as in so many other cases, are mainly reproductions of Garcia's statements.

The Colloquy contains some observations on the geography of Persia and Thibet.

[References.—*Clusius* (*Acosta*), p. 15; *Linschoten*, II., p. 100; *Ainslie*, I., p. 208; *Fluckiger and Hanbury*, p. 366; *Khory*, p. 378.]

COLLOQUY XXXIV.

DAS MANGAS.

[The Mango, *Mangifera indica*, Linn.]

Garcia extols the mango fruit above all the fruits of Portugal. He says those of Hormuz are so good that when they are in season no other kinds of fruit can be sold, save to those who cannot pay the high

price demanded for the mangos. The mangos of Gujarat were well flavoured, though small; those of Balaghat were larger and delicious, especially those of Chacana (Chakan), and Quidar (Chandor ?), Madanager (Ahmednagar), Dultabado (Daulatabad); those of Bengal, Pegu, and Malacca were also very good. Garcia says he had a tree in his island of Bombay (*see* Colloquy XXII.) which yielded two crops of fruit, one early in the year and another in May.

Parenthetically he mentions that the orange and its allies in India were better than those of Portugal.

The Colloquy contains an account of the Banians and Brahmins, and the well-known hospitals for sick animals in Cambay. Reference is made to the often confusing fact that the term India was frequently applied by the Ancients to Ethiopia (*i.e.* Africa). Garcia explains the origin, and defines the proper limits of India. There is also a curious discussion as to the origin of the term *Farangi* used in the East for Europeans.

[References.—*Clusius* (*Acosta*), p. 68; *Bontius and Piso*, lib. vi., cap. v., p. 94; *Linschoten*, II., pp. 23–26; *Khory*, p. 226.]

COLLOQUY XXXV.

Da Margarita, ou Aljofar, e do Chanco; donde se fuz o que chamamos Madreperola.

[Of the pearl or seed pearl, and of the shell of which is made what we call mother-of-pearl.]

Called *perla* in Spanish, and *perola* in Portuguese, the small kind being called *aljofar* in both languages (from the Arabic *al jauhar* ?); *unio* in Latin for the large, and *magarita* for the small; *lulu* in Arabic; *mote* in Persia and India; *motu* in Malabar.

He says *perla* and *perola* are from the Latin *prefero* or *preferes*, because it has the pre-eminence; *unio* because it is unique. He derives the Arabic name from *Julfar*, near the Strait of Hormuz, a place where it is found, not as above, from *jauhar*, jewel, which is now the commonly given though perhaps less correct derivation.

He mentions the principal localities in the Persian Gulf and off the coast of Ceylon where pearls are obtained. He relates that the King of Portugal spent more than the profits of the Ceylon fishery on the support of over 50,000 Christians.

Inferior pearls were obtained in China and Borneo. He refers to those brought from America as wanting in roundness and having dead waters. The largest pearl from Cape Comorin which he had seen weighed 100 grains of wheat, or 25 *quilates* (carats); it was valued at 1500 *crusados* (= £212). Pearls were cleaned and polished with pounded rice and salt.

[References.—*Linschoten*, II., pp. 133–136; *Ainslie*, I., pp. 292–297.]

COLLOQUY XXXVI.

DO MUNGO, MELÃO DA INDIA, A QUE CÁ CHAMAMOS PATECA.

1. [*Munga*, green gram, seeds of *Phaseolus mungo*, Linn.]

It is called *mexe* by Avicena, cap. 489, and *mes* by Belumense; but it should be pronounced *mex*.

The Colloquy contains very little on this subject save that it is said that the *munga*, as is well-known to be the case still, is given to horses: and that the Gujarati and Deccani physicians give fever patients, after ten or fifteen days' fasting, the water of boiled *munga*, and afterwards the husked seed itself cooked like rice, on which diet a patient accustomed to generous food is liable to starve. It occurs, he says, in Palestine.

2. [*Pateca*, the Indian Melon, perhaps the water melon, *Citrullus vulgaris*.]

Called *pateca* by the Portuguese; *batiec indi* (*báttikh*) by the Persians and Arabs, and by Avicena.

The term *pateca* is generally understood to be the water melon, but Garcia's description of the plant as being tall and not spreading over the ground, and that the leaves are unlike those of melons, makes me incline to the supposition that he means the *papaya*, *Carica papaya*, L., which was introduced from the West Indies. However, the black seeds agree best with those of the water melon, as the seeds of the *papaya* are grey, and Delavalle[1] says that Garcia does not mention the *papaya* because it had not then been introduced from the West Indies. Garcia commends the *pateca* in choleraic fevers, and as a diuretic. Ruano expresses great approval of it as a fruit.

[References.—*Linschoten*, II., p. 35; *Ainslie*, I., p. 216. The *papaya* is figured by *Bontius and Piso*, lib. vi., cap. vi., p. 96.]

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[1] English Translation, London, 1665, p. 69.

COLLOQUY XXXVII.

Dos Mirobolanos.

[Indian Almond—*Terminalia catappa*, Linn; *T. bellerica*, Roxb., and *T. chebula*, Retz., also *Phyllanthus emblica*, Linn.]

Garcia says these were not the "*mirobolanos*" of Dioscorides, Galen, and Pliny, who gave that name to nutmegs. Called *delegi* by Avicena, and *aliligi* by Serapion; *delegi* is the generic name used for all the varieties by the Arabs, and for the "citronos" *asfar*, the "Indios" *açuat*, the "queblos" *quebulgi*, the "belericos" *beleregi*, the "emblicos" *embelgi*.

Our author definitely states that there were five different kinds, produced from as many trees, all of which were wild in different parts of the country. It is now, however, known that some of the recognised varieties owe their differences to their being at different stages of maturity.

The variety principally exported to Portugal was from Dabul and Cambay, the reason being that the further north the fruits were obtained the less subject were they to putrefaction.

In Goa the "citronos" variety, which is round and purged choler, was called by the people *arare*, the "emblicos" *anvale*, the "Indios" *rezanvale*, the "belericos" *gotim*, the "queblos," which were found in Bisnager, Cambay, and Bengal, *aretea*. The "emblicos" or *anvale* was used for a pickle, and for tanning leather, and dyeing. He compares truly enough the leaf of this variety (*Phyllanthus*) to a fern. The other varieties were used in decoctions as purges, and also as conserves. Other details of their medicinal properties are also given in this Colloquy.

[References.—*Clusius* (*Acosta*), p. 39; *Linschoten*, pp. 123–6; *Bontius and Piso*, lib. vi., cap. xxiv., p. 109, fig.; *Ainslie*, I., pp. 236–241, II., p. 128; *Khory*, pp. 294–301.]

COLLOQUY XXXVIII.

Das Mangostæs.

[The Mangosteen, fruit of *Garcinia mangostana*, Gærtn., called in Bombay *mángusatina*.]

Garcia does not appear to have been personally acquainted with this fruit, never having tasted it, and not being aware of its medicinal

properties, which are chiefly situated in the astringent rind; "it affords a common and useful remedy in dysentery and diarrhœa" (according to Dr. R. N. Khory).

Garcia states, from hearsay, that the tree is about the size of the nutmeg-tree, with leaves like those of the laurel, and that it is a native of Malacca. His description of the fruit itself is in the main correct.

[References.—*Linschoten*, II., p. 34; *Bontius and Piso*, lib. vi., cap. xxviii., p. 115, fig.; *Khory*, p. 170.]

COLLOQUY XXXIX.

DO NEGUNDO OU SAMBALI.

[The leaves and whole plant of *Vitex negundo*, Linn.]

Called *negundo* generally; *sambali* (*shambálu*) in Balaghat; *noche* in Malabar.

Garcia describes it as affording a drug so efficacious for fomentations in rheumatic pains, &c., that it almost ruins the doctors' practice. He says it was recommended to a chaste governor by an old apothecary, who mistook it for the Spanish *agnocasto*, as an anti-aphrodisiac.

[References.—*Clusius* (*Acosta*), p. 61; *Ainslie*, II., pp. 252–3; *Khory*, p. 430.]

COLLOQUY XL.

DO NIMBO.

[The *Nim* or *Bakáná* tree, *Azadirachta indica*, Juss. or *Melia indica*, Brandes.]

Garcia says that the leaves, bruised and mixed with lemon juice, have a marvellous healing effect when applied to sores. An oil obtained from the fruit was used in nervous affections, and the juice of the leaves as an anthelmintic.

This well-known tree possesses many medicinal properties besides those mentioned by Garcia.

[References.—*Clusius* (*Acosta*), p. 63; *Bontius and Piso*, lib. vi., cap. ix., p. 99, fig.; *Ainslie*, I., p. 453; *Fluckiger and Hanbury*, p. 135; *Khory*, p. 211.]

COLLOQUY XLI.

Do Amfião, ditto assim corrompidamente porque o seu nome é "opio."

[Of the *Amfiao* corruptly so called, since its correct name is opium.]

[Opium, the prepared juice of *Papaver somniferum*, Linn.]

Called *ofium* or *afium* by the Arabs and Moors, who altered the *opium* of the Greeks by putting *f* for *p*. A small variety was called *caxcux* by the Arabs.

Garcia says there are many different kinds; that from Cairo, which is white, is called *meceri* (*misseri*); that from Aden and other localities in the Red Sea is black and hard; that from Cambay (grown in Malwa, which is still a centre of poppy cultivation), Mandwa, and Chitor is soft and yellow: the prices of these varieties vary with the localities according as they happen to be usually eaten.

Garcia describes the reason why opium is so much used by the natives, but adds that if taken in excess it is liable to produce impotence. The usual amount taken daily was from 20 to 50 grains of wheat in weight; but a certain Khorasani, Secretary of the Nizam, ate three tollahs and a-half, or ten *crusados'* weight every day, and notwithstanding that this produced stupor, he was, when roused, a most able and learned man.

[References.—*Clusius* (*Acosta*), p. 12; *Linschoten*, II., p. 112; *Bontius and Piso*, lib. iv., p. 41; *Ainslie*, I., p. 271; *Fluckiger and Hanbury*, p. 40; *Khory*, p. 145.]

COLLOQUY XLII.

Do pao da Cobra e é de tres Maneiras.

[Snake-wood, three kinds.]

The identity of these is very doubtful, as the descriptions are rather vague. It is possible, however, that they may be identical with the following:—

Cocculus acuminatus, D'C.
Hemidesmus indicus, R. Brown.[1]
Strychnos colubrina, Linn.

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[1] See *Fluckiger and Hanbury*, p. 379, n.

The three kinds are obtained in Ceylon; the most esteemed is called there *rannetul* (*Cocculus* sp.) It is a shrub which grows to two or three *palmos*, &c.: a full description of the plant is given. It is the root which is used both in cordial and applied externally to snake bites. The second is a thorny tree resembling the pomegranate, but climbs on other trees. Of it the wood, bark, and root, constitute the drug. This is probably the *Hemidesmus* or Indian sarsaparilla. Of the third kind, *Strychnos*, the leaves are said to be not green but are thin and long, and speckled white and grey, with white and black spots, and the branches are thin and spread over much ground. The roots were black, and both roots and wood were esteemed as affording an antidote to poison.

The virtues of these plants were first discovered, according to Garcia, by observing that a small animal, the *quil* or *quirpele* (for the Tamil *kiri* or *kirrippillei*, i.e. mongoose), was in the habit of eating them and anointing itself with the juice whenever it fought with the cobra. The Colloquy contains an account of such a contest. As is well known, a belief in the mongoose obtaining immunity from snake bites by eating some plant is still prevalent.

Garcia says the wood was used for worms, smallpox, measles, and cholera (*mordexi*); also to eradicate severe fevers.

He suggests the possibility of the poison for darts used in Malacca (i.e. Borneo?) being prepared from the *Pao da Cobra*.

[References.—*Clusius* (*Acosta*), p. 50; *Linschoten*, II., p. 104; *Flueckiger and Hanbury*, p. 379 n.; *Khory*, pp. 139, 397, and 399.]

COLLOQUY XLIII.

(1) DA PEDRA DIAMO, (2) DA PEDRA ARMENIA, (3) E DA PEDRA CEVAR.

(1) The Diamond—

Names *Adamans* (for *Adamas*) in Latin; *Diamantes* in Spanish; *Diamas* in Portuguese; *Almaz* (i.e. *Almas*) by Arabs and Moors; *Ira* (i.e. *Hira*) in the places in India where it is found; *Itam* (i.e. *Itan*, Malay, from *Hintern*, Javanese) in Malaia (which here stands for Borneo).

Ruano quotes Pliny, in support of the view that the diamond is superior to all other precious stones, after which follow the pearl, emerald, and ruby. Garcia, however, says that the emerald and then the ruby, bulk for bulk, rank before the diamond in India, and he points

out that the loadstone, though it has many more virtues, is sold by Cambay *maos* (i.e. *mands*) equal to 26 pounds, while the emerald is sold by *ratis*, equal to 3 grains of wheat, while the other stones, which in Europe are sold by *quilates* (i.e. carats), equal to four grains, are in India sold by *mangelis*, equal to five grains.[1]

Garcia scouts the idea of the diamond being a poison, referring as a proof to the fact that the black servants sometimes conceal diamonds by swallowing them. He says the natives were in the habit of introducing pounded diamonds with a syringe in cases of stone, but had relinquished the practice in consequence of the belief in its being a poison.

He says diamonds are found in two different localities in Bisnager (i.e. Vijayanagar), and that all stones of 30 *mangelis* and upwards in weight are the property of the King. Another rock or mine with smaller stones, but of better quality (called diamonds of the old rock), is situated in the Decam (i.e. Deccan) in the territory of Imadixa[2] (i.e. Ahmad Shah), called by the Portuguese Madre Maluco (i.e. Ahmed-i-mulk, the country of Ahmad; or Ahmad Malik, the chieftain Ahmad), and they were sold at a market of good repute in the Deccan called Lispor (Ellichpur, the old capital of Berar). The *naifes*, or diamonds having natural crystalline forms, were exported thence by merchants to Goa and even to Bisnager, where they sold for better prices than the amorphous diamonds which were found in that region.

Another source of diamonds was situated, according to Garcia, in the Strait of Tanjampur, in Malacca. This indication of locality has been a source of great confusion, and is the original cause of the erroneous statement repeated in almost every work on precious stones that diamonds used to be found in Malacca. Here, however, Malacca stands for Borneo, and Tanjampur, the Taniapura of Linschoten, for Tandjong Pura, an old capital of Matan, on the West Coast of Borneo. He says the diamonds from this locality were good, though small, but were very heavy.[3]

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[1] Taking the *quilat* or carat as equal to 3·174 Troy grains the *rati* would be 2·38 and the *mangeli* 3·97. From Tavernier, who wrote nearly 100 years later, and used Florentine carats, I deduce a value for the (pearl) *rati* of 2·66, and for the Goa *mangeli* 3·8 Troy grains; elsewhere the *mangeli* was heavier.

[2] This mine was most probably situated at Wairagarh, the Beiragarh of the Ain Akbari (*see* "Economic Geology of India," p. 37)—an ancient mine which is known to have been taken possession of by Ahmad Shah in 1425.

[3] The same is related also by Cæsar Frederick of the diamonds of Iawa, i.e. Borneo. *See* "Tavernier's Travels," English translation by V. Ball, vol. ii., p. 462.

Garcia says crystal (i.e. quartz) is not found in India, because it needs a much colder climate, such as Germany, for its formation: this is, however, a fable. Rock crystals of great size are well known from certain localities in India, and indeed, as might be supposed, the mineral is very widely distributed.

Beryl is, however, he says, found in India, and in such large pieces that pitchers and vases are made from it, and for one of the former he gave 200 *crusados*, or about £28 6*s*. 8*d*. Large beryls do occur in India, but it may be that here he was referring to vessels made of Jade (see next Colloquy). He says that beryl occurred in Bisnager, Cambay, Martaban, Pegu, and Ceylon, but that in the three last diamonds do not occur, which is quite true.

He contradicts the story mentioned by Ruano that the diamond cannot be broken by a hammer, and recommends him not to try the experiment with valuable stones. He says that diamonds cannot be pierced, though some are so hard that they will scratch others, and the diamond point may be used to test whether a stone is a genuine diamond or not. There are numerous instances of diamonds being engraved, and I think diamonds have been occasionally bored too. He adds:—"The story of it being softened by the blood of the goat is a fable taken from seeing it break the stone in the bladder and kidneys. I have tried the experiment with diamonds and found that they remained just as if nothing had been done to them."

Elsewhere[1] I have shown that this fable, which was known to Pliny, probably originated in the bloody sacrifices connected with diamond mining, which sacrifices, moreover, have furnished the explanation of the meat thrown into the diamond valley, which is the leading idea in the stories of Marco Polo, Sindbad, and others.

As to the size which diamonds attain he says there are some in India larger than four hazel-nuts. The two largest he saw weighed 140 *mangelis* (i.e. 175 carats), and 120 *mangelis* (i.e. 150 carats). He had heard of one being in the possession of a man who, however, denied it, weighing 250 *mangelis* (i.e. 312½ carats). Further, he had been told by a man worthy of credit that he had seen one at Bisnager which was as large as a small hen's egg. He relates as strange that diamonds should appear to grow rapidly in a mine if searched for after two years' rest. The true explanation of this is that weathering by breaking up the hard crusts which envelop the diamonds brings them to light.

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[1] "Diamonds, Coal, and Gold of India," Trübner, 1881, p. 134.

He summarily disposes of the myth that diamond cannot cut lead on account of the mercury in it.

Ruano having asserted that one Francisco Tamara says that there are diamonds in Peru, Garcia replies that he does not know as to the truth of the statement, but adds that the same author tells fables about Indian diamonds.

"He says, for instance, that serpents keep watch over the diamonds, in order that no one should take them, but that if persons having diamonds in their hands throw down, at some distance away, meat prepared in a certain way, the serpents will eat it, and these persons may then take the diamonds at pleasure. It would be well if Francisco de Tamara wished to relate fables that he would do so about his own Indies and not about ours."

Garcia then contradicts statements by Pliny as to the occurrence of true diamonds in Arabia, Cyprus, and Macedonia—[The report as regards Arabia probably originated in diamonds from India being obtainable as merchandise in the marts of that country. The Cyprian and Macedonian stones were obviously not true diamonds]—after which come the following passages:—

Ruano. It is said that all diamonds attract iron, and, what seems most strange to me, it is also said that the loadstone will not attract iron when the diamond is near.

Osta. This about the diamond attracting iron you would see was wrong if you tried the experiment, and the notion that the loadstone will not attract iron when the diamond is near is quite without foundation. I have tried the experiment before many people, both with diamonds of the "old rock" and diamonds of the "new rock," and if you desire it I will try it before you. It is not unreasonable that the other properties ascribed to this stone may be true. For it is right that the stone which God created to be so invincible should have the properties they mention, although the saying that if it be placed under the head of a sleeping woman without her knowing it she will on awaking embrace her husband if he be faithful, but fly from him if he be not. I cannot believe, although I am told that authors of repute state it as a fact, because the same property has been ascribed to certain herbs, which we know to be mere superstition. But one thing I will tell you, which I have seen in very fine diamonds of the "old rock," and that is, that when rubbed together they will adhere, and in such a manner as not to come apart. The diamond when heated will also, as I have seen, lift up a piece of straw like amber. These things

I have seen, as you may if you wish, and therefore I believe them. Although some writer shows how to counterfeit stones I will not tell it to you, as it is not fit work for a philosopher, much less for a theologian. This writer shows how to make diamonds from water sapphires, but after all they are but sapphires, and not diamonds, although they appear like them.

(2) *Da pedra Armenia.*

[Armenian stone.] As the identity of this stone is a point of some interest, I quote the whole of the passages referring to it here :—

R. Because all this discourse must not be on things foreign to physic, I wish you to tell me whether you have seen the Armenian stone in these countries. We have not got it in Europe, although the *lapis lazuli*[1] is found in many places.

O. I will order the Armenian stone to be brought here. Girl, give me that key!

S. Here it is.

O. Open the parcel of large stones.

S. There, it is open.

O. Now you see the Armenian stone.

R. They have many marks that you speak of; for although they have something blue about them, yet they are bright green. But how do you know that they are Armenian stones?

O. The Moors, the great physicians who cure the Nizamoxa, gave me these stones, and they use them to drive away melancholy. These stones are called, in Arabic, *Hager Armine*, which is the same as *Armenian stone.* I asked where they were to be found, and was told in Ultabado, a well-known city of Balagate. I asked also whether they were found in Turkey or Persia and heard that they had been seen there, but only in very small quantities. The Moors did not know whether the stones came from Armenia or not. I may say that this medicine purges very little, as I have found from experiment. I have asked many Armenians here in India whether these stones were found in their country, but they could not tell me.

[I am inclined to believe that this Armenian stone, which is mentioned by many early writers, was either Azurite combined with Malachite or a green variety of Turquoise, known as Callainite, which is found at Nishapur, in Persia and a few other localities, but has not been recorded from India.]

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[1] Perhaps, rather, berg-blau or lazulite? as the true *lapis lazuli* is of very rare occurrence.

The Arabians held it in the highest esteem, saying "it cures all diseases of the head and heart. Worn on the fingers in a ring it brings about happiness of mind, dispels fear, ensures victory over enemies, and removes all risk of getting drowned or being struck with lightning, or of being bitten by snakes or scorpions."

The city of Ultabado, mentioned above, was the well-known city of Daulatabad in the Deccan, where the mineral was probably on sale.[1]

(3) *Da pedra Cevar.*

[Loadstone]. The following quotation is also of sufficient interest to be given in full:—

R. The loadstone is a very common thing, and I wish to ask you what you know about it, because Laguna and others say that it is a poison and that it makes men mad.

O. The loadstone does not make men mad, nor is it a poison; it is believed by the natives that taken in small quantities it prevents them from growing old, and preserves their youth. The King of Ceylon, for instance, when an old man, ordered little pots of this stone to be made, in order that food might be prepared in them for him.

R. How do you know this?

O. The story is very well known. Isaac of Cairo told it to me, and he it was who was ordered to make the pots. This Isaac is a Jew, who carried to Portugal the news of Sultan Badur's death.

R. Antonio Musa says that the Portuguese, who sailed to Calicut, found there ships with wooden nails, and made thus on account of the mountains of loadstone that they might attract iron nails.

O. This is not true, for the Portuguese never saw such a thing. In Calicut and along all this coast there are more ships made with iron nails than with wooden ones. It is true that in the Maldive Islands there are ships with wooden nails, but the reason is that the natives do not care to spend the money for iron ones.

R. It is said also that the loadstone mines are closely connected with iron mines, and from that circumstance the loadstone attracts iron.

O. It is no such thing, for the loadstone occurs in many places where there is no iron.

R. One Pariense, a philosopher, says that the loadstone attracts iron by virtue of a property that is placed in it in order that it should

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[1] See *Linschoten*, II., p. 144, n. 7, for early references, &c.

move to the stone and therefore the loadstone does not weigh more with much iron than it does with little.

O. I and others have found by experiment that this is not true; but you must therefore not be astonished, because man cannot penetrate into everything.

[Readers will probably remember that Sindbad tells the same story as that quoted above from Antonio Musa, which proves that the properties of the loadstone were observed at an early period. And in conjunction it may be mentioned that as a matter of fact enormous deposits of magnetic iron occur in several parts of India, especially in southern India. Garcia does not appear to have known that loadstone is an ore of iron. His experimental demonstration of the myth, as also of others elsewhere, marks a stage of progress. The explanation by Pariense the philosopher is delicious.]

COLLOQUY XLIV.

DAS PEDRAS PRECIOSAS, QUE SAO, SAFIRA, JACINTO, GRANADA, RUBI, MEDICINAES.

[Concerning medicinal precious stones: the sapphire, jacinth (or hyacinth), garnet, and ruby.]

R. Now let us speak, for it is most necessary to physic, of the precious stones which enter into compounded medicines and electuaries.

O. I can only tell you of the medicinal stones which are found in India, for if we were to speak of all kinds we should never come to an end. Indeed, I only speak of such as enter into the electuary of *gemis*, commonly called *fragmenta precosia*.

R. Tell me of these now, and afterwards I will ask you some questions about other stones.

O. I will do so in a few words—and yet it is more necessary to advise you to take away ten *crusados* worth of these other stones, in order to give them to the apothecaries of Castile, that they may henceforth buy the genuine stones—and they are not so dear. The first is the sapphire, a stone that deserves to be rated very highly, though it is bought for little money. The blue colour of this stone is very agreeable to the sight. There are two kinds of it, one very dark and the other very light. The latter kind we call *safira de agua* (water sapphire), and it is not of a very great price. Sometimes the lighter stones are mounted with a certain foil, which makes them appear so

much like diamonds that some people are deceived. Both of these kinds are found in Calicut, in Cananor, and in many parts of the kingdom of Bisnager. Those found in Pegu are, however, much better, and those found in Ceylon best of all. But although these stones are so pleasant to the eye, you will never find one, however big and clear and good in water, that comes up to one thousand *crusados* or one thousand *pardaos*. This I say from what I have heard in these countries. When you go to Cochin you can buy in Calicut and in Cananor any quantity of the pieces that remain after the stones are cut, and whole stones too, for they cost very little money.[1]

R. Tell me about jacinths and garnets.

O. Of these there is such an abundance that you will need but little money to buy a bagful of them. You will find many in Calicut and in Cananor. The cut stones are sold at the rate of a *corja* (that is a score) for a *vintem*, and the uncut ones very much cheaper. The garnet is found in such abundance not only in these countries, but also in all the lands of Cambaia and of Balagate, that it is sold in the markets at a very low price.[2]

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[1] The colours of sapphires range from watery translucent and absolutely colourless transparent white, through many shades of blue up to dark blue, approaching even to black.

As to the former working of deposits containing sapphires in any part of peninsular India I have no definite information, and some of the reputed discoveries of sapphires have turned out on close examination to refer to other stones. That sapphires do occur in India is not only rendered probable by the fact of the numerous localities where the coarser kinds of corundum are found, but is absolutely established by the recorded fact that they are to be found in the sands of the seashore of Travancore, where with rubies (i.e. red sapphires), Oriental topazes (i.e. yellow sapphires), garnets, and jacinths, they form bands of colour assorted by the waves (Dr. William King, Rec. Geol. Survey of India, vol. xv., p. 89).

Since very early times the sapphires of Ceylon and Burmah have been a regular commodity for sale and export in the Indian markets. I have elsewhere described the discovery of sapphires in the Himalayas, but there is no record of the existence of that source having been known before the year 1880 (*Proceedings Royal Dublin Society*, Pt. VII., vol. iv., 1885).

[2] The term jacinth or hyacinth is one which at different periods appears to have done duty as a name for very different stones. In early times it appears to have been applied to a variety of corundum, indeed it is derived from the Arabic and Persian *yacut*, i.e. ruby. By jewellers ("Precious Stones and Gems," by Edwin Streeter, Part II., p. 81) and possibly here also by Garcia, it is applied to the hyacinthine variety of garnet, otherwise known as cinnamon stone. By mineralogists it is now restricted to clear varieties of the mineral known as zircon (or jargoon). Its colours vary from white, green, and yellow to red. From a colourless variety which presents great brilliancy and refractive energy a false diamond

R. Now go on with the sardonyx.

O. This stone is not found in this country, and if there are any here they come from abroad. Besides, there is much difference in opinion as to what stone it is. In my opinion, when you cannot obtain it, you may substitute for it the jacinth and garnet. And the jacinth is also found near Lisbon, at a place called Bellas, and therefore might possibly be found in many places in Spain if it were sought for. Some say that these two stones, jacinth and garnet, are species of ruby.

R. And what do you know of the ruby and carbuncle.

O. Under the name of ruby a great many species are placed. The principal is that in Greek called *anthrax* and in Latin *carbunculus*, which means a small lighted coal.

R. This I wished to have by me and not use it in pharmacy, because I have heard that it gives out light at night.

O. You must not believe this, for it is an old wife's tale.

R. And have you not seen it or heard it alleged that it had this property?

O. I have certainly never seen it. It is true that a lapidary told me that he was once counting on a table a few very fine small stones which came from Ceylon, and which we call *rubis de corja* (that is sold by the score), and he says that one remained fixed between the joints of the table, and in the darkness of night there appeared as though a spark of fire was upon the table, so he took a lamp to the table. He found this very small ruby, and after he removed it the spark disappeared. Whether this is true or false I do not know. I know it was told to me by that lapidary, and they are people whose business causes them sometimes to tell lies, because lies bring them profit; and they get into such a bad habit that they sometimes tell them merely for the sake of telling wonderful stories.

R. Now when the ruby is very fine both in colour and water—or in other words if it be twenty-four carats in colour, should we call it a carbuncle?

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is made. This is sometimes spoken of as a Matura diamond, from its occurrence in a district of that name in Ceylon.

The *grenade* of Garcia is the *granat* of Tavernier, so called from its resemblance in colour to the fruit of the pomegranate. It is the stone we call garnet and sometimes carbuncle, but the carbuncle of the Romans was the anthrax of the Greeks, i.e. the ruby, as stated further on by Garcia.

Garnets of good colour are very abundant in India ("Economic Geology of India," p. 521), and some choice specimens rival the spinel and even the ruby in lustre.

O. I think so, and I have seen some specimens of that stone which is called *toques*, the price of which is fixed according to the size, shape, and water. The most costly one I have seen was one that was said to be worth twenty thousand *cruzados*. It belonged to a great lord of the Deccan, who showed it to me because I was a very great friend of his, but made me give my word that I would not speak of it to the people of that country nor to their king. He told me that it cost him six mãos of gold, which is nearly five Portuguese *arrobas* (= 160 lbs.).

R. This was good for use in medicine according as the apothecaries are liberal?

O. No, for medicine you will find plenty as cheap as the jacinth, and therefore you must take away a large quantity to Spain. There is another species which is called *balax*, which is somewhat red and of less value. There is also another called *espinhela*, and is of a colour more nearly approaching that of a live coal, and like the Balas ruby is sold at a lower price, because they have not the water of the true ruby; some are mostly white. There are others that incline somewhat to the carnation in colour, or more properly speaking to the white cherry when almost ripe. Some rubies are partly white and partly red, others partly sapphires and partly rubies. I have seen all these kinds, and if you will allow me I will show them to you before you go. Although there are many other kinds of rubies I will not speak of them, because they are not very well known nor their values.

R. Would you be so good as to tell me the reason of these variations in the colours of rubies?

O. The most reasonable cause that I have heard is that the ruby at its very beginning in the rock is white, and in growing it gradually approaches that state of perfection which is a bright red. But since it cannot arrive suddenly at that state of perfection we find it sometimes as I say, a bright red, at other times with bands of red and bands of white; and because the ruby and the sapphire are said to be of one rock, it happens that stones are found half ruby and half sapphire. There are other stones in which is mixed a blue with the red, that appears like a composition of dark blue and red, and is something of a purple. These stones are called in some of the languages of these countries *nilacandi*, which is the same as saying *ruby* and *sapphire*.

Note on the Ruby and Carbuncle.—As is remarked by Garcia, under these names a great number of varieties or species have been included. It has been already mentioned that garnets even have been known to rival the ruby in lustre, and have been so called till the mistake has been discovered. Spinels too are often called rubies by jewellers, though they are different from them in composition and crys-

talline form, and in not possessing dichroism like the ruby. The pinkish varieties of spinels are sometimes distinguished as Balas rubies, which title is derived from Balkh, the chief town of Badakshan, where there are spinel mines of great antiquity. The red topaz has also been mistaken for the ruby, and probably so also has the red zircon or hyacinth.

Of the occurrence of true rubies in India definite information is wanting at least as to the existence at any time of regular mines. In all respects the remarks made above as to the sapphire apply to the ruby also, but it should be stated as to the occurrence of both, in Ceylon and in Burmah, that while Ceylon produces the sapphire abundantly and the ruby sparingly, the exact converse is the case in Burmah.

As to the phosphorescence or rather fluorescence of the ruby it is to some extent founded on fact, and was very generally believed by the ancients. According to the Talmud, it is said that Noah illumined the recesses of the Ark by means of the light given out by precious stones.

R. Tell me the names of these stones in Arabic and in the language of this country.

O. The Arabs and Persians call the ruby *yacut*, and the people of this country call it *manica*.[1] The jacinth and grenade have specific titles as yellow *ruby* and black *ruby*. The grenade and sapphire are called *nild*.

R. A stone much more important you have not told me of, viz. the emerald, which enters into the electuary of "*gemis*" under the name of *ferrugesi*.

O. Emeralds are not so cheap that they may be mistaken for *ferrugesi*. Emeralds are very scarce and of very great price, and their true matrix is not known. In fact there are not fragments enough left. Whoever says that *ferrugesi* means the same as emerald does not know Arabic. Nor was it the intention of Mesue to introduce the emerald in this composition, although Cristofaro de Honestis, commentator of Mesue, thinks differently. The reason of this is because in Persian and in the language of this country the emerald is called *pachec*, and in Arabic *zamarrut*. And Serapion in the chapter on emeralds, where he says *zabarget* should have said *zamarrut*. It should not be *tabargat*, as the Pandetaries think.[2]

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[1] *Manica* = Sansk. *Manikya*.

[2] The question of the sources whence Eastern nations obtained emeralds in early times is one which I have at present in hand; but it cannot be fully dealt with in a footnote. It may be said, however, that mines at Zabara, &c., in Egypt, furnished the principal part of the supply. *Pachec*, this is said to be from the Malayalam *pacca*, green colour. *Zamarrut* for *zomorad*, Arab., whence the European names *smaraude*, *smaragd*, *emeraude*, emerald. (See *Linschoten* in Hak. Soc., II., p. 140.,

R. Well, what does *ferrugesi* mean?

O. You must know that F and P are in Arabic closely akin (as I have before told you). Hence in the Arabic of Mesue the word is *perugesi*, which mean *sturguesa*, or turquoise. For *perusa* in Arabic means turquoise, and of these there is an abundance in all parts of Persia.[1]

R. Truly I should have come to India for this matter alone, and if I had not found you perhaps they would not have told me about it there. Henceforward whenever I meet the word *ferrugesi*[2] in Avicena or in any Arabic book I shall understand turquoise, and not consent to the apothecaries putting green smalt in the electuary of *gemis*, nor will I put faith in other green stones. I remember a few days ago someone came to you here to sell a jewel set with many small emeralds, and you told me that they were all false, and that in Balagate and Bisnager they were made from the glass of bottles, and that they were so common there they were not at all sought after. And therefore when I shall see the emerald I shall say sooner than put it in the electuary without exactly knowing what it is, *viride vitro libera nos domine.*[3] And moreover the emeralds of Peru, says a modern writer, are very bad for use in medicine.

O. I may tell you that these emeralds of Peru have been brought into this country and at first were very highly valued, but afterwards when they were found to be false no one would give money for them at all. Therefore you must be careful of these stones also.

R. Tell me about the turquoise and whether it is used in medicine or not.

O. Some say it is and others say it is not used by the natives; yet all the Moors say it is used in medicine among them.

R. Tell me of the amethyst, of the chrysolite, the beryl (for you say that it is not found in this country), of the *alaqueca*, and of the jasper.

O. I will not speak of jasper, because there are more of these stones in your country than in this, and you know more about them than I. I may say, however, that there are small cups of jasper or of some green

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[1] The chief source of turquoise is at Nishapur in Persia.

[2] *Ferrugezi* for *Perugezi* = Turquoise, *Firozaj* is the Arabic form of the Persian *Firoja*.

[3] The art of making false emeralds of glass is of very great antiquity. Some years ago I identified some as such which were supposed to belong to the period of Asoka. See *Proceedings* As. Soc. Bengal, 1881, p. 89.

stone that resembles the emerald,[1] and it may be that the piece that is in Genoa which is said to be emerald is really of this stone. And the Genoese speak as they wish, because I was given in Balagate a cup for two hundred *pardaos*: and if it had been emerald they would not have given me the thousandth part of it for that money, such is the value of the emerald there. I have told you of the beryl when speaking of the diamond, that a very large quantity of them are found in Cambaia, Bisnager, and Ceylon, and many other places. The chrysolite is found in Ceylon and the amethyst also. In Balagate of the Nizamoxa (Nizam Sha) these stones are found and many others.[2] The stone called by us *alaqecca*[3] and by the Arabs *quequi* is valued at an *arratel* cut in small pieces for a Spanish *real*, and this stone possesses more virtue than all the others, for it staunches the blood very quickly.

R. The cat's-eye appears to me very good; where does it come from?

O. The finest are found in Ceylon, and are more highly prized there than in Portugal. I have seen one brought from Ceylon to Portugal, which in Ceylon was valued at six hundred *cruzados*, and yet in Portugal no more than ninety were offered for it. And this stone was brought back to Ceylon and sold for its proper value. Therefore you must not take any of these stones from here to Portugal as merchandise.

R. What properties has it?

O. The people of this country say that it has the power of preserving a man in his riches, so that he shall not lose any of what he has, but yet may increase it.

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[1] Jade? from Karakash, the *yu* of the Chinese.

[2] *Note on the Beryls found in Cambay, Martaban, Pegu, and Ceylon.*—The most famous beryl mines of India were situated at Kangiam in Coimbatore, and from thence it is not improbable that the famous *Vaidura* stones were derived, of which mention was made as early as the sixth century in the "Brihat Sanhita" (see, however, Max Müller in "What India can Teach Us," p. 266).

Beryls are found occasionally in other parts of India, but not so far as I am aware in Cambay. In Burmah they have been obtained in the bed of the Irrawadi. The beryl or aquamarine of Kangiam was sometimes of large size, though perhaps not equalling the huge crystals of late found in America: one I have seen, which is now in the Museum of the Boston Natural History Society, measures upwards of 3 feet in diameter.

Possibly beryls, found elsewhere, were cut and polished by the lapidaries of Cambay. As for Ceylon I have no information of the occurrence of beryl there, but chrysoberyl is one of the recognized productions of the island. The chrysolite which is mentioned may perhaps be topaz rather than peridote; the latter does not occur in Ceylon.

[3] *Alaqueca* for *Al'akik*, Arab., carnelian, bloodstone.

R. Where are the rubies found which you have told me about?

O. A few are found in Ceylon which are very good, others come from Pegu, and it is said that they come from the country of Brama,[1] which is very far distant. And this is the best information that I have. If I err you must pardon me, for I do not know all things thoroughly.

COLLOQUY XLV.

Da pedra Bazar.

[Bezoar, a name given to various intestinal calculi.]

Called *bazar* (*padzahr*) by Persians (*budizahar* or *bazahr*) by Arabs. Corruptly *bezar* in Europe.

Garcia explains that bezoar was found in the stomachs of goats and sheep, the best quality being from Persia and Khorassau. It was also obtained in Malacca (Borneo?), and in the Island of Vacas (cows) off Cape Comorin.[2] He says it was formed by concretions in successive layers, like those of an onion, on straws. The larger the stone the greater its medicinal virtue. One which he had weighed 8 drachms, and was sold with much difficulty for 32,000 *reals* in Portugal, but it had cost more in India.

It was used as an antidote to melancholia and poison. Rich persons purged themselves with it twice a year, in March and September, and continue with doses of 10 grains for five successive mornings, in order to renew their youth. Generally it was esteemed as an aphrodisiac.

Garcia commends it for itch,. leprosy, ringworm, quartern fevers, &c. Taken in quantity it was supposed by some to be injurious. He says it was useful when placed in powder on poisonous wounds and bites, and in the treatment of sores arising from the plague. Doses of 2 grains in rose water enfeebled the poison of smallpox and measles.

[I think some of the reputed snake stones consisted of bezoar. In spite of the vast reputation it formerly enjoyed it is now regarded to be inert as a drug.]

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[1] See for recent accounts of the Ceylon and Burmah sapphire and ruby mines Tavernier's Travels, English transl., vol. ii., Appendix, p. 465.

[2] Linschoten, vol. ii., p. 144, says it was near Cambay, and Tavernier (English trans. by V. Ball, vol. ii., p. 146) gives a full account of it. He mentions its being found at Renquerry, a place not identified, in Golconda.

[References.—*Clusius* (*Acosta*), p. 58 ; *Linschoten*, I., p. 120 ; II., pp. 142–145 ; *Bontius and Piso*, lib. iv., p. 47 ; *Ainslie*, I., pp. 35–37 ; *Khory*, pp. 90 and 97.]

COLLOQUY XLVI.

DA PIMENTA PRETA, BRANCA E LONGA, E CANARIM, E DOS PECEGOS.

[Of pepper, black, white, long, and Kanarese, and of peaches.]

(I.)—Pepper—*Piper nigrum*, the black and white *P. longum*, the Kanarese abortive pepper corns.

Called *molanga* (*molago*) in Malabar; *iada* in Malacca (Borneo ?); *filfil* by the Arabs; *meriche* (*miricha*) in Gujarat and Deccan; *merois* (*maricha* ?) and *pepilini* (*pipali*) for the longer kind in Bengal.

Garcia says pepper is grown throughout Malabar and along the coast from Cape Comorin to Cananor. Also in Malacca (Borneo ?), Java, Sunda, and Queda, the latter being consumed locally, and in China, Pegu, and Martaban. That from Malabar is consumed locally and sent to Balaghat, and a considerable portion is exported by the Moors, contrary to the prohibition of the king, to the ports of the Red Sea.

Dioscorides and those who followed him, including Pliny and Galen, the Arabs, &c., described the plant from originally false information. Garcia then gives a full description of the habit of the pepper vine, and corrects the errors of his predecessors. He says the Malabar species (*P. nigrum*) has no more resemblance to the Bengal species (*P. longum*) than beans have to eggs.

He does not give the medicinal properties of the white and black pepper, but shows that they are identical, save that in the former the pericarp is removed. The Kanarese variety, he says, is good for removal of phlegm, for toothache, and was given for *mordexi* (i. e. cholera). It was not exported to Portugal.

[References.—*Clusius* (*Acosta*), p. 33 ; *Linschoten*, II., pp. 68–75 ; *Piso in Mantissa Aromatica*, p. 181 ; *Ainslie*, I., pp. 306–8 ; *Fluckiger and Hanbury*, p. 519.]

(II.)—Peaches.

Garcia having offered a conserve of peaches from Persia to Ruano, the latter asks whether it is true that the peaches of Egypt were poisonous, but that when transplanted to Persia they lost the poison.

Orta explains that this fable originated with Dioscorides about a fruit which he calls *persea* (?). Ruano says the conserve of peaches was good, but preferred that made with the *pimenta* or pepper grapes. Good peaches introduced from Persia were cultivated in Balaghat.

COLLOQUY XLVII.

Da raiz da China.

[China root—*Smilax china*, Linn.]

Called *lampato* in China—[*chob-i-chini* in India.]

Garcia says that this root was first brought from China to Goa in 1535, and it supplanted the root *guaiaçao* (*Guiacum officinale*, Linn.) of which he had himself brought a supply from Portugal, as a cure for syphilitic diseases. The merciful God, he says, provided this remedy, as the *morbo napolitano* is common in India, China, and Japan. He highly extols the merits of the infusion of this wood. Also in cases of palsy, arthritis, gout, sciatica, King's evil, indigestion, melancholia, stone, ulcers in the bladder, &c., while it also possessed remarkable powers as an aphrodisiac.

When first brought to Malacca it sold at the rate of 10 *cruzados* (= £1 8*s*. 4*d*.), a *ganta* = 24 ounces; afterwards it fell to 20 *reis* a *ganta*. It was believed to have cured the Emperor Charles V. of his gout; but in spite of its wide reputation at one time, though still used in India, its efficiency is doubted in Europe; it is, however, recognized as a sudorific and alterative. Sarsaparilla has displaced it from most pharmacopœias.

[References.—*Clusius* (*Acosta*), p. 47; *Linschoten*, I., p. 239; II., pp. 107–112; *Ainslie*, I., pp. 70–72 and 592; *Fluckiger and Hanbury*, p. 648; *Khory*, p. 547.]

COLLOQUY XLVIII.

Do Ruibarbo.

[Rhubarb—Root of *Rheum officinale*, Baillon.

Called *ravao Chini* by the Moors; *ravao Turquino* in Europe (as in modern times, incorrectly, Turkey rhubarb).

Garcia says that all the rhubarb which came to India was shipped at Hormuz, reaching it through Usbeque (Tartary), from China by land;

an inferior kind was reported to be produced in Samarcand. He says a month's journey by sea does more to injure it than a year's by land. All the best qualities are land-borne. In Colloquy XII. he mentions that rhubarb was very liable to decay in India, scarcely lasting through the four months' rainy season.

Garcia acknowledges that his information on this subject is defective.

[Rhubarb is not much used in India; it is not even mentioned by Khory].

[References.—*Clusius* (*Acosta*), p. 46; *Linschoten*, II., p. 101; *Ainslie*, I., pp. 342–4; *Fluckiger and Hanbury*, p. 442.]

COLLOQUY XLIX.

DE TRES MANEIRAS DE SANDALO.

[The three kinds of Sandal wood. The white and yellow (the heart wood) *Santalum album*, Linn. The red, *Pterocarpus santalinus*, Linn.

Called *chundana* in Malacca (Borneo?); *circanda* (*sukhada*) by the Deccanis and Gujaratis; *sandal* by the Arabs (*chandanu* Hind and Beng, &c.)

Garcia says the white and yellow Sandal grow in Timor, and other Malayan Islands, but the red (*vermelho*) is obtained from Tenasserim, and on the Coromandel coast. The latter is used in fevers, but the chief use is in the manufacture of idols. The yellow and white kinds grow in the country beyond the Ganges. Both natives and Moors anoint themselves with it dissolved in water. Garcia is in error in stating that it differs from "Brazil" wood in not yielding a dye. He gives a full description of the varieties obtained in the different ports.

He says a false sandal which was used for the same purpose was found in Malabar: it was called *sambarume*. Odorous woods were also obtained from the island of S. Lorenzo (i.e. Madagascar), and in some places on the coast of Melinda (N.E. Africa).

[References.—*Clusius* (*Acosta*), p. 23; *Linschoten*, II., p. 102; *Bontius and Piso*, lib. iv., p. 43; *Ainslie*, I., pp. 376–9; *Fluckiger and Hanbury*, p. 540; *Khory*, p. 509.]

COLLOQUY L.

Do Spiquenardo ou Espiquenardo.

Spikenard, the root of *Nardostachys jatamansi*, D'C.

Called, *cahsçara* (*kalishada*) in Mandou (Mandu),[1] Chitor,[2] and parts of Bengal near the Ganges; *cembul indi* (*sumbul-ul-aspire-hindi*) by the Arabs.

Garcia says that the abundance in which genuine drugs were then obtainable had caused much less falsification and substitution than had been practised in ancient times.

The spikenard grew, he states, in Mandu, Chitor, and parts of Bengal, bordering the Ganges. This is a mistake. It came probably from Nepal. He mentions parenthetically the pilgrimages of the natives to the Ganges and Narbada? the pilgrims having in the latter case to pay a tax to the Nizam. He alludes to pagodas in Bengal and Orissa, probably those at Benares and Jagannath.

He says that the two varieties known as *siria* and *indica* by Dioscorides are identical. He denies that a poison called *pisso* was prepared from it.

Ainslie gives an account of the various opinions which have been held as to the identity of this plant.

[References.—*Clusius* (*Acosta*), p. 45; *Linschoten*, II., p. 126; *Bontius and Piso*, lib. iv., p. 45; *Ainslie*, II., pp. 367–8; *Khory*, p. 352.]

COLLOQUY LI.

Do Spodio or Espodio.

[*Tabashir.*—Silicious concretions in *Bambusa arundinacea*, Schultz.]

This was really *tabashir*, being different from the *espodio* of the Greeks, which was *tutia* or *pomfolix* (i.e. oxide of zinc). Garcia attributes the misapplication of the term to Davo Terenciano (Gerado Cremonense) who mistranslated *tabascir* by *espodio*, and others likewise when translating from Arabic into Latin made the same mistake.

Called *tabascir* (*tabashira*) by the Persians and Arabs *Espodio dos*

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[1] Mandu, the old Capital of Malwa. [2] Chitor, the old Capital of Rajputana.

gregos of the Spanish was *tutia* and *espodio dos Arabios* was tabasheer; by the Indians it was called *sacarmambu*, i.e. sugar of the bamboo.

Garcia says that *tabascir* means milk, &c., that hibernated or was concealed.

It was largely purchased in India by Persians and Arabians for export. Garcia describes the plant, and says the internodes were a *palmo* (cubit) long and that the tabasheer was generated at the knots. He alludes to a myth of the Arabs, that it was produced by burning the roots of the cane, and adds that if the carpenters met with it they anointed their loins with it and their foreheads if they had headache. He points out the errors of the ancients with regard to its origin. It was used by the native physicians for both external and internal inflammation, for fevers, and as an astringent in choleraic fluxes.

[References.—*Clusius* (*Acosta*), p. 17; *Linschoten*, II., p. 56; *Piso, Mantissa Aromatica*, pp. 185–187; *Ainslie*, I., pp. 419–21; *Khory*, p. 559; *Cohn* in *Cohn's Beiträge*, Bd. IV., p. 365. See also Yule's Glossary, pp. 674–5.]

In my remarks on the Bamboo made on former occasions to the Academy I pointed out that the "Indian reed" of Herodotus was not, as had generally been supposed, the bamboo, but was the Palmyra palm, and that it had furnished the canoes of which he writes. I further pointed out that the bamboo never grew to a size consistent with the statements of some writers. It was evident that there must have been some mistake in the quotations from Acosta. Accordingly I now give a translation of an extract from Acosta's chapter on tabasheer, which shows that in parts of India the internodes of the bamboo were used as cylinders for flotation not as canoes. This in addition to what I have previously published on the subject finally disposes of the myth.[1]

"Sometimes those trees or canes called *mambu*, in which tabasheer is formed, are found of such size and thickness that skiffs are made of them which are able to carry two men each, not indeed by excavating them, but by cutting them to lengths of two internodal spaces [*lit.* cutting them off (*excidentes*), leaving only two internodal spaces] like skiffs. Pairs of naked Indians are wont to get on (for it is the custom to go naked in this country) and to sit one at each extremity with crossed legs and holding in each hand an oar three or four palms in length, with which they propel these skiffs with such dexterity that they are even able to navigate rapid streams against the current with the greatest speed, as I have seen with my own

[1] *Proc.*, ser. ii., vol. ii., pp. 366–337, and *antea*, pp. 6 and 8.

eyes in the river of Cranganor, in which, skiffs made from that cane are much used because those who use them consider themselves to be safe from crocodiles, which they call caymans," &c., C. Acosta. "*Aromatum*, &c.," Antwerp, 1582, p. 17.

COLLOQUY LII.

Do Squinanto ou Esquinanto.

[The plant and root of a grass *Andropogon laniger*, Desf.]

Called *cachabar* (*izakhara*) and *haxiscaçule* in Arabia; *alaf* in Persia; *hérva de Mascate* in Goa; *adhar* by Avicena, and *adher* by Serapion, the flower *foca* by Arabs and Persians. It grows in Mascate (Muscat) and Calaiate in Arabia as grass does in Spain, and is eaten by cattle there.

Garcia says it was used medicinally by the Portuguese and Arabs in India, but not by the natives.

This Colloquy is largely taken up with exposing the errors of Dioscorides and other writers as to the affinities of this plant.

There are several other species of *Andropogon* in India which yield fragrant oils.

COLLOQUY LIII.

Dos Tamarindus.

[The tamarind fruit, *Tamarindus indica*, Linn.]

Called *puli* in Malabar; *ambili* (*ambuli* and *amali*) in Gujarat and other parts of India; *tamarindi* (*tamara hindi*, i.e. Indian date) by the Arabs.

Garcia describes the tree very correctly. He commends the infusion of the pods as a purge. The bruised leaves were used by the Indian physicians for poultices, Mesue being quoted by Ruano as having stated that the tamarind is the fruit of the *Palma sylvestris*, Garcia disposes of this and adds that the palms in India did not bear dates, the latter fruit being imported from Arabia. He was evidently unaware that the date palm was cultivated in his time in Sind.

In this Colloquy allusion is made to Cairo and the pyramids.

[References.—*Clusius* (*Acosta*), p. 40; *Linschoten*, II., 6, 119–122; *Bontius and Piso*, lib. vi., cap. iv., p. 93, fig.; *Ainslie*, I., pp. 425–8; *Fluckiger and Hanbury*, p. 197; *Khory*, p. 240.]

COLLOQUY LIV.

Do TURBIT.

[The root and stems of *Ipomæa turpethum*, R. Brown.]

Called *turbit* by the Arabs and Persians; *barcamum* by the Gujaratis; *tiguar* by the Kanarese; *terumba* by a Banian in Diu.

Garcia describes its habit as like ivy, and that it grows near the sea. The gum or resin is produced from the thick part of the stem by twisting or puncture. It grows wild most abundantly in Cambay, Surat, Diu, Bassein, and adjoining districts, and in Goa, but is there considered to be of inferior quality. It was exported in great quantity to Persia, Arabia, and Turkey, and some was sent to Portugal. Dried in the sun it becomes white, but if dried in the shade it is black. The drug was used as a purgative, and was known to Avicena. A large part of this long Colloquy is taken up with an exposure of the many errors about this plant to be found in the older authors. The true *turbit* was not known, he says, to the Greeks.

This chapter contains accounts of the cities of Diu and Bassein, of Elephanta, and the island of Salsette.

COLLOQUY LV.

Do THURE (QUE É INCENSO) E DA MIRRHA.

[Concerning *thure*, which is incense, and of *Myrrh*.]

(1) Olibanum or frankincense obtained from several species of *Boswellia* found in the Somali country.

Called *olibano* by the Greeks; *lovam*, *conder* (*kundura* and *gonda*), and *samac*, by the Arabs. Avicena calls it *conder* and Serapion corruptly, *ronder*.

The best kind was obtained from trees which grow on rugged mountains. It was purchased from the King of the (Somali) country by merchants from Aden and Xael, and was sold in Goa at two *cruzados* a *quintal*. The Indian physicians used much incense for unguents and perfumes, and it was eaten for ailments of the head and for flux. The largest export trade was to China. Garcia says it was not obtained in India.

This is not strictly true, as *Boswellia thurifera*, the *salai* tree, which is abundant in some parts of the country, also yields it.

[References.—*Ainslie*, I., p. 264; *Fluckiger and Hanbury*, 120; *Khory*, p. 210.]

(2) Myrrh. The identity of the tree yielding myrrh is somewhat doubtful, but it is probably *Balsamodendron cistus*. Garcia says he knows little about myrrh, but had heard that the Bedouins brought it to Brava and Magodoxa by land, as they said from Chaldee. His remarks include mention of the Magi who came to worship Christ, and as to the nature of the star by which they were guided; but with such subjects he dealt cautiously, not knowing how they might be regarded by the Church.

Ainslie, I., pp. 243, 616–7; *Fluckiger and Hanbury*, 124 and 129; *Khory*, p. 209.

COLLOQUY LVI.

Da Tutià.

[*Tutia* (*Spodio* of the Greeks, see Colloquy LI., *pomfolix* was probably a purified form of it), impure oxide of zinc.]

Garcia's account of *tutia* is somewhat vague and incorrect. He says that it was an error of the ancient writers to suppose that *tutia* was obtained in India, though used there as well as in Portugal. He says it was made in a region of Persia, called Guirmon from the ashes of wood called *goan*, and was called Alexandria from its being shipped at Alexandria for Europe. It was one of the *antespodios* of the Greeks.

[Its preparation from the ashes of wood is absurd. The sulphate may have been collected as an efflorescence from rocks in Persia, as it is known to be in Afghanistan now, and the oxide prepared from it by roasting.] Garcia does not mention its medicinal uses. Parenthetically he mentions that the native physicians knew how to pulverize iron, steel, and mercury.

[References.—*Ainslie*, I., p. 575; *Khory*, p. 41.]

COLLOQUY LVII.

Da Zedoaria e do Zerumbete.

[*Zedoary* and *zerumbet*, the roots of *Curcuma zeodaria*, Roxb., and *C. zerumbet*, Roxb.]

Zerumbet is called *Zeruba* (? *Zhuranabada*) by Arabs, Persians, and Turks; *cachora* (*kâchura*) by Gujaratis, Decanis and Kanarese; *çua* by the Malabars.

It abounds in Calicut and Cannanor, growing both wild and cultivated; the plant resembles ginger, but the leaf of the *zerumbet* is wider and the root larger. The root when steamed and dried is exported to Hormuz and Arabia, whence it goes to Alexandria and Jedda and from thence to Venice, &c. It is also made into a conserve which is better than that made of ginger.

Zedoaria Garcia ascertained to be identical with, in fact a corrupt name of what Avicena calls *geiduar*, which came from China and was a medicine of great price, and useful in the treatment of snake bites. It had the reputation with a Mahomedan physician of being good for 36 ailments, but principally as an antidote to poison.

This Colloquy mainly consists in an attempt to explain the confusion and contradiction about these drugs in the writings by Greeks and Arabs which we cannot follow here, but must refer the reader to Ainslie's exhaustive article on the subject.

[References.—*Ainslie*, I., pp. 490–4; *Khory*, p. 523.]

COLLOQUY LVIII.

[Treating of some things which have come under the notice of the author relating to the medicines before mentioned, and so are added some few other medicines or fruits, and speaks of a kind of rice which has butter within it, and of the *betel*, and of the city of Badajoz, and of the *Cana fistula*, and of the *sirifoles*, a much praised medicine for fluxes, and of the city of Chitor, and of the *marfrim*, and of the *mangostans*, and of the *patecas*, and of the *pao da China*, and of a stone, much esteemed as an antidote to poison, which is obtained from the porcupine.]

In this Colloquy Dimas Bosque contributes his comments and criticism on what has gone before. He first refers to a variety of rice exported from Java, called *pulot*, which when cooked with steam appears as if it had been dressed with butter. He says *betel* is very sensitive to handling, and can stand neither excessive heat nor cold; then follow some remarks as to the derivation of the name Badajoz, as to the abundance of the *Cana fistula* in Malacca and Siam, and the derivation of the name Chitor. He then extols the virtues of the *marmelos* of Bengal (*Ægle marmelos* or *bale* fruit) in the treatment of fluxes; very justly too as most persons who have lived in India well know. Garcia gives a very fair description of the tree and fruit, and points out that it was by no means peculiar to Bengal, being found also

in Western India it was called *cirifole* (*siphal*) by the vulgar, and *beli* by the physicians.

Then follow some remarks on the durian and mangosteen, on *marfim* or ivory, on the *ananas* or pine apple, the *patecas* or Indian melons, and the *pao da China* (*Smilax china*) which as Dimas points out, is a creeper growing like ivy.

The virtues of the stone obtained from the porcupine in Pam, a country adjoining Malacca, as an antidote to poison are then discussed. It was said to be of a bright red colour, bitter to the taste, and feeling like French chalk to the touch. In a case of poison it was steeped in water, and the water, which thereby acquired a bitter taste, was given to patients to drink, with good results. Garcia welcomes it as an additional antidote in a land where poisoning is so prevalent.

[Captain Hamilton,[1] says the place which produced the porcupine bezoar was the Island of Lingen, 20 leagues from Jambu, and as far from the river of Johore: it formed a portion of the Johore Dominions. Castanheda[2] mentions an animal called *bulgoldorf* as producing a stone in its head which was an infallible and highly esteemed antidote against poison.]

Note.—In a short Appendix some additional information is given with reference to several of the above subjects and some others, but it is not important.

[1] New account, vol. ii., p. 123.
[2] See Kerr's "Voyages and Travels," vol. ii., p. 439.

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LII.

OBSERVATIONS OF THE VARIABLE STAR μ CEPHEI.

By J. E. GORE, F.R.A.S.

[Read January 26, 1891.]

The following are my observations of this variable star, the "garnet star" of Sir W. Herschel, from January 1, 1888, to December 31, 1890. They form a continuation of the observations given in these *Proceedings* (*antea*, page 166).

The observations have been reduced to the scale of the Harvard Photometry, and the comparison stars used were—

	Mag. H. P.
ζ Cephei, . . .	3·54
ϵ ,, . . .	4·24
ν (10) Cephei, . .	4·50

The observations were made with a binocular field glass, having object glasses of 2 inches aperture, and a power of about 6 diameters. It will be seen that the variation did not exceed half a magnitude during the years 1888–90.

The position of μ Cephei for 1890·0 is

RA $21^h\ 40^m\ 8^s$.
N $58°\ 16'·5$.

All the observations were made in the West of Ireland, except that on August 26, 1888 (made in London).

Observations of μ Cephei = B.A.C 7582.

Date.	Estimated Magnitude.	Remarks.
1888		
Jan. 2, —	3·97	Clear, no moon.
Jan. 5, —	3·97	,, ,,
March 1, $8^h\ 30^m$	4·07	Clear sky, no moon.
,, 4, 7 50	4·07	Very clear sky, no moon.
Aug. 26, 9 10	4·18	Clear sky. Observation made in London.
Sept. 29, 8 20	4·02	Clear sky, no moon.
Nov. 13, 9 25	4·12	Clear sky, strong moonlight.
Dec. 5, —	4·12	Clear, no moon.

Observations of μ Cephei = B.A.C 7582—*continued.*

Date.			Estimated Magnitude.	Remarks.
1889				
Jan.	16,	—	4·02	Clear, full moonlight.
,,	26,	—	4·18	Clear, no moon.
Feb.	27,	—	4·14	,, ,,
March	1,	—	4·19	,, ,,
,,	8,	9h 25m	4·10	Clear, moonlight.
,,	30,	—	4·19	Tolerably clear, no moon.
April	24,	—	4·18	Clear, no moon.
July	28,	10 0	4·07	Hazy, no moon.
Aug.	20,	9 55	4·18	Clear sky, no moon.
,,	30,	9 40	4·22	Clear, but somewhat hazy.
Sept.	4,	9 0	4·26	Clear sky, moonlight.
Oct.	7,	9 2	4·26	Clear, moonlight.
,,	12,	7 37	4·18	,, ,,
,,	16,	7 50	4·14	Clear, no moon.
,,	24,	7 45	4·07	,, ,, μ very reddish, near zenith.
Nov.	16,	7 1	4·02	Very clear, no moon.
Dec.	16,	7 53	4·09	Clear, no moon.
,,	18,	—	4·12	,, ,,
1890				
Jan.	11,	—	4·07	,, ,,
,,	24,	—	4·06	Clear, moonlight.
Feb.	4,	—	3·97	Clear, strong moonlight.
,,	8,	8h 0m	4·02	Clear, no moon.
,,	14,	8 44	4·07	,, ,,
,,	17,	8 50	4·07	,, ,,
,,	26,	—	4·02	Clear, moonlight.
March	2,	8 28	3·98	Clear, strong moonlight.
,,	13,	8 30	4·07	Clear, no moon.
,,	16,	8 0	3·98	,, ,,
,,	30,	7 55	3·92	Very clear, strong moonlight.
April	17,	9 0	4·02	Clear, no moon.
Aug.	6,	9 30	4·02	,, ,, μ very reddish.
,,	17,	9 30	4·02	Very clear.
,,	29,	—	4·00	Very clear, moonlight, μ very reddish.
Sept.	4,	—	4·02	Clear, no moon.
,,	7,	9 8	4·02	Very clear, no moon, μ very reddish, near zenith.
,,	18,	9 3	4·03	Clear sky, no moon.
Oct.	17,	9 52	4·00	Clear, no moon.
Nov.	7,	7 17	4·02	,, ,,
,,	16,	6 30	4·02	,, ,,
Dec.	29,	6 45	3·97	Very clear, moon not risen.

The above observations will show that the variation of light is very irregular, and that the star sometimes remains for several months with little or no perceptible change.

LIII.

REPORT ON A COLLECTION OF ECHINODERMATA FROM THE SOUTH-WEST COAST OF IRELAND, DREDGED IN 1888 BY A COMMITTEE APPOINTED BY THE ROYAL IRISH ACADEMY. By W. PERCY SLADEN, F.L.S., F.G.S., Secretary of the Linnean Society. (Plates XXV. to XXIX.)

[Read June 23, 1890.]

The Rev. W. S. Green kindly asked me to report upon the collection of Echinodermata obtained during the dredging cruise of 1888. The Committee were fortunate in obtaining an interesting series of forms. Forty species are enumerated in the following lists, viz.:—Crinoidea, 1; Asteroidea, 17; Ophiuroidea, 6; Echinoidea, 10; Holothuroidea, 6. Four of the species of Asterids and one of the Echinids are new. Several of the other forms are either rare or extend our knowledge of their geographical and bathymetrical distribution. The novelties consist of a new species of Hymenaster, a new species of Pteraster, two new species of Pentagonaster, and one new species of Porocidaris. The collection as a whole furnishes striking evidence of the richness of the locality, for it is not a little remarkable that so large a number of species of Echinoderms should have been taken from the comparatively limited number of eight stations. The majority (24 species) were dredged from depths of 345 and 750 fathoms, and are consequently important additions to our lists of the Fauna of the British Area.

I.—CRINOIDEA.

1. *Antedon rosacea* (Linck).
   Locality—Long Island Sound. Depth 4 fathoms.

II.—ASTEROIDEA.

1. *Plutonaster bifrons* (Wyv. Thoms.), Sladen.
   Locality—Lat. 51° 1′ N.; Long. 11° 50′ W. Depth 750 fathoms.
2. *Pontaster limbatus*, Sladen.
   Locality—About 56 miles off Dursey Head. Depth 345 fathoms.

3. *Astropecten irregularis*, Linck.
   Depth 345 fathoms.
   Depth 24 fathoms.
   Depth 50 fathoms.

4. *Psilaster Andromeda* (Müller & Troschel), Sladen.
   ? locality.

5. *Luidia ciliaris* (Philippi), Gray.
   Depth 52 fathoms.

6. *Luidia Sarsii*, Düben & Koren.
   Depth 5 fathoms.

7. *Pentagonaster balteatus*, n. sp. (Plate xxv., figs. 1–5.)
   Rays five. R = 22 mm.; r = 13 mm.; R = 1·69 r. The minor radius is thus in the proportion of 59 per cent.

General form flat and moderately thick. Marginal contour pentagonoid with lunate sides, having the radial angles slightly produced, and obtusely rounded at the extremity. Interbrachial arcs forming a wide, regularly sweeping curve. Margins rather thick and almost equally rounded actinally and abactinally. Abactinal area slightly inflated in the central and radial regions, and slightly depressed in the interradial areas near the margin. Actinal area subplane, with slight depressions in the interradial areas.

The abactinal area is covered with rather large hexagonal plates, those in the median radial line being larger than the others, excepting only the basal plates, and two or three adjacent plates in the interradial areas, which are subequal to the largest in the median radial series. All the plates diminish in size as they approach the margin. The abactinal plates do not quite reach the extremity of the ray in consequence of the junction of the penultimate and antepenultimate supero-marginal plates of the two sides of the ray in the median radial line. The surface of the plates is covered with large, low, uniform hemispherical granules, which are not crowded so as to actually touch, or at any rate modify the form of the separate granules. The tabulum is surrounded by a single series of similarly low granules, the outer edge of which is sharply cut in conformity with the contour of the hexagon, as if the latter had been "dressed" with a knife. The abactinal surface of the tabula in the radial regions is slightly convex. Occasional plates (but very few) bear a single small excavate pedicellaria, with two short spatulate jaws.

The supero-marginal plates, which are eight in number, counting from the median interradial line to the extremity, form a broad and conspicuous border to the abactinal area, the breadth of which at the median interradial line is about 3·75 mm.; and it diminishes very slightly towards the extremity of the rays. The plates near the interradial line have their breadth fully twice their length. The length of the plates is equal up to the fifth and then diminishes, the breadth being greatly in excess throughout. The ultimate plate is very small and wedge-shaped, with the apex directed towards the median radial line. The surface of the plates, which is slightly convex in the transverse direction, is entirely covered with rather large, low, uniform, flatly hemispherical granules which, though closely placed, are not so crowded as to modify the form of the granules. The odd terminal plate, though very small, is larger than the ultimate supero-marginal plate; it is shield-shaped or subcordiform, with the apex adcentral, and thickened and turned abactinally towards the outer margin.

The infero-marginal plates, which are nine in number, counting from the median interradial line to the extremity, correspond to the superior series for two or three plates on each side of the median interradial line, but alternate with them along the outer part of the ray. The breadth is about twice the length at the median interradial line, but diminishes gradually up to the antepenultimate plate, where the proportions are subequal. The infero-marginal plates are covered with granules similar to those on the superior series. I have not detected the presence of pedicellariæ on either series of marginal plates.

The adambulacral plates are rather broader than long. Their armature consists of a marginal series of six, rather short, obtusely pointed or rounded spinelets, which are flattened transversely, and with a tendency to become prismatic; the adoral spinelet being much shorter than the others, and placed further back on the plate. The marginal series is followed by a second regular series of three short, robust, prismatic, pointed papilliform spinelets; and the outer part of the plate is occupied by three series of three uniform papilliform granules. These granules are usually regularly placed as above described, but occasionally a little irregularity occurs. They are intermediate in size between the very short papilliform spinelets of the second series, which are little more than elongated granules, and the true granules of the actinal intermediate plates. Near the outer extremity of the furrow one of the papilliform spinelets of the second series becomes very large and robust. I have found no pedicellariæ on the adambulacral plates.

The mouth-plates are elongate and triangular, but not conspicuous. Their armature consists of a marginal series of nine or ten short, equal spinelets, similar to those in the furrow series on the adambulacral plates, but with a tendency to become more distinctly prismatic as they proceed inward; a series of six to eight large, low, coarse and distinctly prismatic granules, forming a longitudinal series on the actinal surface of the plate parallel to the suture which unites the two mouth-plates of an angle; and an intermediate series between these two series of about three similar prismatic granules.

The actinal interradial areas are paved with rather large sub-rhomboid intermediate plates, arranged in series parallel to the ambulacral furrows. The surface of the plates is covered with rather large, low, uniform, distinctly-spaced, hemispherical granules, which are arranged in straight series along the margins of the plates, but show no definite order within this boundary.

The anal orifice is sub-central, and on the right posterior side of a plate larger than those in the immediate neighbourhood.

The madreporiform body, which is small and polygonal in outline, is situated at about one-third of the distance between the centre and the margin. The surface is marked with rather course irregular convolutions. On its adcentral side is a single large basal plate, larger than the madreporite itself; and a similar large basal plate is present in each of the other interradial areas in a corresponding position, and larger than any of the other abactinal plates.

Colour in alcohol, a bleached yellowish white.

Locality.—Lat. 51° 1′ N.; Long. 11° 50′ W. Depth 750 fathoms.

Remarks.—This species has more distinctly lunate sides, and more obtusely-rounded radial angles than *Pentagonaster granularis*, Retz., sp., to which at first sight it presents some resemblance. It is at once distinguished, however, by the great width of the marginal plates, which are much broader than long, by the complete granulation of the marginal plates, by the armature of the adambulacral plates, which has more spines in the furrow series, and a greater number of series on the actinal surface of the plate. Pedicellariæ are also more numerous and more distinctly entrenched.

8. *Pentagonaster concinnus*, n. sp. (Plate xxvi., figs. 1–5.)

Rays five. $R = 22$ mm.; $r = 12$ mm.; $R = 1{\cdot}83\,r$. The minor radius is thus in the proportion of 54·5 per cent.

General form flat, and rather thin. Marginal contour a deeply

lunate pentagonoid or stellato-pentagonal, with the radial angles produced, and tapering to an acute extremity; interbrachial arcs regularly rounded, the curve being that of a part of a circle. Margins rather thin, bevelled abactinally, more abruptly rounded actinally. Abactinal area capable of slight inflation. Actinal area plane.

The abactinal area is covered with small subcircular plates, closely placed, only the three medio-radial series of plates being separated by papulæ. The abactinal plates do not extend to the tip of the ray, the three supero-marginal plates preceding the ultimate, uniting with the corresponding plates on the other side of the ray in the median radial line. The margin of the tabulum is surrounded by a series of small, rather broad granules, moderately spaced, and the surface of the tabulum is covered with a small, uniform, well spaced, hyaline granulation. I have not detected the presence of pedicellariæ upon any of these plates.

The supero-marginal plates, which are eight in number, counting from the median interradial line to the extremity, form a well-defined border to the abactinal area, of uniform breadth throughout. The plates near the interradial line have their length rather greater than their breadth, but these proportions gradually become equalized, when the fourth or fifth plate from the median interradial line is reached; and the antipenultimate and penultimate plates have the breadth slightly greater than the length. The ultimate plate is small and wedge-shaped, with the apex directed towards the median radial line. The abactinal surface of the supero-marginal plates is slightly convex, which causes each plate to be distinctly defined. A few small uniform hemispherical granules are present on the lateral wall of the plate, which rub off with the slightest touch. Whether the whole surface of the plate was during life covered with similar granules I am unable to say, but I am inclined to think that such was not the case. A few large, isolated, irregularly placed pits are present on the surface of the plate, more numerous near the junction of the abactinal and lateral areas. A series of small granules surrounds the margin of the plate. The odd terminal plate is conical and larger than the ultimate supero-marginal plates; it bears at the apex a robust, obtuse, short, papilliform spine.

The infero-marginal plates are eight in number, counting from the median interradial line to the extremity. The three plates on each side of the median interradial line have the length subequal to the breadth, but in all the succeeding plates the length is greater than

the breadth. The ultimate plate is small and corresponds with the ultimate supero-marginal plate. The infero-marginal plates bear precisely similar granules to those on the superior series, their presence now being similarly confined to the lateral area, and the single series surrounding the margin. On the naked portion of the actinal surface of the plate large isolated pits occur, and occasionally a granule is present therein. I have detected no pedicellariæ on either series of marginal plates.

The adambulacral plates are slightly longer than broad, and their armature consists of three regular series; the first or furrow series being true spinelets, whilst the second and third, which are on the actinal surface of the plate, are only granules. In the furrow series are five or six short obtuse cylindrical spinelets which are directed over the furrow, the adoral spinelet of the series being often placed further back on the plate than the others, and it is sometimes also much smaller. The second and third series consist of a longitudinal row of four or five granules, the outer series being similar to the granules on the actinal intermediate plates, and the second series only slightly more elongate or papilliform. I have found no pedicellariæ on the adambulacral plates, in fact nowhere on this example at all.

The mouth-plates are small, but fairly conspicuous. Their armature consists of a marginal series on each plate of eight spinelets similar to the marginal or furrow series on the adambulacral plates, the innermost spinelet being rather larger than the others, and subprismatic. On the actinal surface of the plate is a longitudinal series of eight granules parallel to the suture which unites the two mouth-plates of an angle; a series of four granules parallel to the margin adjacent to the adambulacral plates; and an intermediate series, also of four granules, traversing the surface of the plate between these two series. The granules in each of these series become slightly more papilliform as they approach the free margin.

The actinal interradial areas are paved with small, normally rhomboid but occasionally polygonal, intermediate plates. They are arranged in series parallel to the ambulacral furrow. The plates of the series adjacent to the adambulacral plates are slightly larger than the others, and this series, which is the longest, does not extend beyond the third infero-marginal plate, counting from the median interradial line. The surface of the plates is covered with small, low, uniform granules, which are well spaced, and exhibit no arrangement excepting the series which marks out the margin.

The anal orifice is slightly excentric, and is surrounded by

several rather larger plates than those in the central region generally.

The madreporiform body, which is small and suboval in form, is situated nearer the centre by about its own diameter than midway between that point and the margin. Its surface is marked with rather coarse irregularly convoluted striations. On its adcentral side is a single large basal plate larger than the madreporite itself, and a similar large basal plate is present in each of the other interradial areas, in a corresponding position, and larger than any of the other abactinal plates.

After the foregoing description was written, and the drawings to illustrate it had been made on stone, I found a larger example of the species at the bottom of a tin, which had unfortunately escaped my notice previously. This specimen measures $R = 54$ mm.; $r = 31$ mm. There are eleven supero-marginal plates, counting from the median interradial line to the extremity, exclusive of the odd terminal plate. Four plates preceding the ultimate unite with the corresponding plates on the other side of the ray in the median radial line. A greater number of longitudinal series of abactinal plates in the radial areas are separated by papulæ; and small foraminate pedicellariæ are occasionally present on the abactinal plates. In the armature of the adambulacral plates there are usually six spinelets in the furrow series, followed by five and six in the second and third series, the second series being subpapilliform.

The actinal surface of the infero-marginal plates is covered with widely-spaced pits, upon which granules are borne. The widely-spaced granulation imparts a peculiar character to the ornamentation of these plates. The actinal intermediate plates are very large in relation to the size of the plates on the abactinal surface. In other respects this example accords with the description above given, excepting the slight modifications dependent on larger size.

Colour in alcohol, a bleached yellowish white, with a slight brownish shade.

Locality.—Lat. 51° 1′ N.; Long. 11° 50′ W. Depth 750 fathoms.

Remarks.—This species is allied to *Pentagonaster granularis*, Retz., sp., but is distinguished by the more pointed rays, by the union of the supero-marginal plates in the median radial line at the extremity of the ray, by the ornamentation of the marginal plates, by the character of the abactinal plates, and by the armature of the adambulacral plates.

9. *Nymphaster protentus*, Sladen.

? Locality.

A single example measuring R = 101 mm., *r* = 28 mm. There are occasional small pedicellariæ on the marginal plates, but no spiniform granules whatever are present. The occasional presence of small spiniform granules on the marginal plates of large specimens of this species from the S.W. Coast of Ireland has been noted by Professor Jeffrey Bell[1] in examples dredged by the Rev. W. Spotswood Green, and by myself[2] in an example dredged by Mr. G. C. Bourne. Mr. Bourne[3] has given expression to the opinion of Canon Norman, that *Nymphaster protentus* is, in its younger condition, indistinguishable from *Pentagonaster subspinosus* of the "Blake" expedition described by Perrier in 1884. Mr. Bourne[4] has accordingly cited the specimens dredged by him under the name of *Nymphaster subspinosus*. The smallest examples of *Nymphaster protentus* which I have examined do not, however, support that view, and the character of the series of specimens in various stages of growth, which I have examined, appear to me to strengthen the opinion that the species are distinct.

10. *Zoroaster fulgens*, Wyville Thomson.

Locality—Lat. 51° 1′ N.; Long. 11° 50′ W. Depth 750 fathoms.

11. *Stichaster roseus* (O. F. Muller), Sars.

Depths 50–52 fathoms.

12. *Neomorphaster eustichus*, Sladen.

Locality—Lat. 51° 1′ N.; Long. 11° 50′ W. Depth 750 fathoms.

13. *Pteraster personatus*, n. sp. (Plate xxvii., figs. 1–5.)

Marginal contour substellate; interbrachial arcs well indented and somewhat angular; the minor radial proportion being about 35 per cent. R = 70 mm. (approximately); *r* = 25 mm.

Rays very broad at the base and tapering to a fine extremity, which is sharply recurved; general form depressed; abactinal surface convex over the disk, and bevelled gradually to the margin; lateral fringe not conspicuous, or perhaps only on the inner part of the interbrachial arc.

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[1] "Ann. and Mag. Nat. Hist.," ser. 6, vol. iv., p. 435, 1889.

[2] "Journ. Marine Biol. Assoc." (N.S.), vol. i., p. 327, 1890.

[3] *Ibid.*, p. 327.

[4] *Ibid.*, pp. 307, 308.

The supradorsal membrane is rather thin and very fibrous, the fibres in the tissue being very fine, numerous, and closely interlacing. The paxillæ are numerous and closely placed, having crowns of three or four (or more) long, thin, needle-like spinelets, articulated on a long pedicle. In the central region of the disk more spinelets may be present. The spinelets have the appearance of being very protuberant, the membrane hanging closely for a considerable distance from the tip, which gives a very spinose character to the abactinal surface. No regularity in the arrangement of the paxillæ is superficially discernible. The membrane is semi-transparent, except when old and thick. The spiracula are small, irregular in position, and few in number. The oscular orifice, though moderately large, is inconspicuous; the spinelets of the valves are numerous, long, and much crowded.

The ambulacral furrows are broad, slightly petaloid, and taper towards the extremity. The tube-feet are very large, with a large, puffy, centrally-invaginated terminal disk. The armature of the adambulacral plates consists of a comb of five spinelets. The innermost spine is the smallest, measuring from 1·75 to 2 mm. in length, and is placed at the aboral end of the plate, and the outermost spine is the longest, being between 5 and 6 mm. long. The comb forms a regular semicircular curve, passing from the aboral end of the furrow margin of the plate to the outer margin of its actinal surface, the comb, which traverses the actinal surface of the plate, being curved round aborally at the margin of the furrow. All the spinelets are united by web, which is delicate, semi-transparent, and deeply indented between the spinelets; and it falls almost perpendicularly from the outermost spine of the comb, and does not extend far out upon the actino-lateral spines.

The segmental apertures are moderately large. The aperture-papilla is thick and rather jawbone-shaped, and is free on the aboral side only, forming a slightly angulated lip.

The mouth-plates are of moderate size, and, though rather short, are widely expanded laterally. The keel along the median line of junction is high and broad, and prominent aborally. Each plate bears an armature of five mouth-spines, which form a webbed comb situated entirely on the horizontal margin of the plates; the innermost spine is the longest, measuring between 5 and 6 mm. in length, the outermost two very small, the last being about 1·5 mm. in length. The series of spines on each plate are united by web, but the two combs of a mouth angle are separate and independent. No secondary or superficial spines are present on the actinal surface of the plates.

The first or most adoral transverse comb of the adambulacral plates of two neighbouring rays are closely approximated at their attachment to the actinal membrane behind the aboral peak of the mouth-plates, but they are not joined together.

The actino-lateral spines are long, rather delicate, and closely placed, and extend to the margin of the actinal surface. The spines are horizontal in their disposition, forming a flat actinal surface to the disk; and the fringe appears to extend very slightly beyond the margin. The longest spine, which measures 11 mm. or a little more, is the seventh or eighth, counting from the mouth-plates; and those on the outer part of the ray are very small.

Colour in alcohol, a dirty ashy grey, with a slightly purplish tinge on the actinal surface.

Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

Remarks.—This species presents in a very striking manner the facies of a *Hymenaster*, and appears in many respects to hold an intermediate position between that genus and *Pteraster*. It may readily be distinguished from other forms by the disposition of the actino-lateral spines, by the character of the armature of the adambulacral plates, and by the absence of secondary or superficial spines on the actinal surface of the mouth-plates.

14. *Hymenaster giganteus*, n. sp. (Plate XXVIII., figs. 1–3.)

Marginal contour pentagonal, the indentation of the interbrachial arcs being slight, and more or less masked by an irregular and excrescent growth of the web. Rays slightly produced and recurved. The minor radius is in the proportion of from 64 to 68 per cent. R = 160 mm., r = 102 mm. These measurements are, however, only approximate, and are taken on the actinal surface, where there is much distortion and inflation. The general form of the example described is more or less distorted by inflation. On the abactinal surface the radial areas are well marked out, distinct from the fringe and interradial membrane, and have the appearance of being elevated above the general surface as viewed from above superficially. The lateral web is largely developed, thick, full, and in consequence somewhat irregular.

The supradorsal membrane, which is thick and opaque, is furnished with very numerous clearly-defined muscular fibres, which radiate from the tips of the spinelets and pass to those standing in close proximity around, the bands crossing at various angles, overlying and underlying one another, and forming a thick interlacing and irregularly reticulated

tissue. The spiracula, which are small, are moderately numerous, and usually isolated, that is to say, one only in a mesh. The paxillæ appear to have normally three spinelets, which are aggregated close together, so as to form a crown of small expansion. The paxillæ are widely and equidistantly spaced, and a more or less distinctly longitudinal arrangement may be observed. The tips of the spinelets protrude prominently, and the muscular fibres are not tightly stretched, but hang like slackened ropes round a tent-pole, the tips of the spinelets appearing in consequence like conical prickles upon the abactinal surface, those on the central half of the disk being especially long and prominent.

The oscular orifice is very large and conspicuous; the valves are formed of large robust spinelets, the longest measuring about 16 mm.; and all are united by a thick fleshy web, which gives a tubular character to the structure when the spinelets of the valves are erect.

The ambulacral furrows are very wide throughout, and are only slightly constricted until quite near the extremity. The armature of the adambulacral plates consists of two rather short, conical, tapering spinelets, about 3·5 mm. in length, and robust at the base, covered with membrane which forms a full, wide, terminal sacculus, extending for a distance greater than the length of the spine beyond the tip. Both spines are placed on the furrow margin of the plate, and radiate slightly apart. The aperture-papillæ are large, and have a wide and elongate sacculus, which gives them the appearance of an elongate, uniformly broad flap with obtusely-rounded extremities.

The mouth-plates are large and conspicuous; widely expanded laterally, the keel along the junction being high and abrupt and prominently produced aborally, and with a small abrupt peak adorally. Each plate bears a robust secondary or superficial spine on the side of the keel about one-third of the distance from the adoral to the aboral extremity of the plate, and a second similar spine stands near the adoral margin. The mouth-spines proper are three in number, short, robust, and conical, placed on the margin of the lateral flange of the plate.

The actino-lateral spines are long, robust, and widely-spaced, tending to meet the corresponding spines of the adjacent ray in the median interradial line, where there is much thickening and excrescent growth near the margin.

Colour in alcohol a dirty, yellowish, ashy-grey, with purplish traces on the actinal surface.

Mr. W. F. de V. Kane, who made a number of admirable drawings

on board ship during the cruise, which he has kindly sent for my inspection, informs me that the actinal surface of this starfish (of which he made a sketch) was of a deep blood-red colour before the specimen was placed in alcohol.

Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

Remarks.—This species is unlike any of the other Atlantic forms described. It resembles *Hymenaster pellucidus*, Wyville Thomson, in the formula of the adambulacral armature, but is at once distinguishd by its large size and coarse habit, as well as by the whole character of the abactinal surface. In the last-mentioned aspect *Hymenaster giganteus* is perhaps more nearly related to *Hymenaster glaucus*, Sladen, from South of Omae Saki, off Japan, than to any other species, but it is distinguished by the general form and habit, by the character of the supradorsal membrane, by the character of the adambulacral armature, and by the armature of the mouth-plates. *Hymenaster giganteus* is distinguished from *Hymenaster membranaceus*, Wyv. Thomson, by the difference of the supradorsal membrane, of the armature of the adambulacral plates and mouth plates.

15. *Cribrella oculata*, var. *abyssicola*, Norman.
    Locality.—As last. Depth 750 fathoms.

16. *Asterias rubens*, Linné.
    Locality.—Long Island Sound. Depth 4 fathoms.

17. *Brisinga coronata*, Sars.
    Locality.—About 56 miles off Dursey Head. Depth 345 fathoms.

III.—OPHIUROIDEA.

1. *Ophioglypha lacertosa* (Linck), Lyman.
    Locality.—Long Island Sound. Depth 4 and 5 fathoms.

2. *Ophioglypha albida* (Forbes), Lyman.
    Depth 6 fathoms.

3. *Ophioglypha signata*, Verrill.
    Locality.—About 56 miles off Dursey Head. Depth 345 fathoms.

A young example, which approaches very closely indeed in character to *Ophioglypha affinis* (Lütken), Lyman. The form of the mouth-shields in this specimen resembles that of *O. affinis* much more

closely than that of the figure given by Mr. W. E. Hoyle[1] of *O. signata;* and the uppermost arm-spine is not so long as described by Verrill, it being scarcely longer than the middle one.

4. *Ophiopholis bellis* (Linck), Lyman.
Depth 50 and 54 fathoms.

5. *Ophiothrix fragilis* (O. F. Müller), Müller & Troschel).
Depth 5 and 50 fathoms.

6. *Ophiobursa hystricis*, Lyman. (?)
Locality.—About 56 miles off Dursey Head. Depth 345 fathoms. Fragments of rays only, in bad state of preservation.

IV.—ECHINOIDEA.

1. *Dorocidaris papillata* (Leske), A. Agassiz.
Locality.—About 56 miles off Dursey Head. Depth 345 fathoms.

2. *Porocidaris gracilis*, n. sp. (Plate XXIX., figs. 1–5.)

Form circular, sub-globular, depressed, the height when measured from the summit of the convex apical system is nearly three-fourths of the breadth, or in the proportion of 72 per cent., the greatest diameter being 18 mm., and the height 13 mm. The test is depressed on the abactinal surface, moderately inflated at the ambitus, and gradually contracted below that line.

Ambulacra straight and very narrow, the breadth being slightly less than one-fourth the breadth of the interambulacral area at the widest part. Poriferous zones only slightly sunken; pores very small, in simple pairs, conjugate; the pairs placed obliquely, the inner pores being the lowest; and there are five pairs of pores opposite one of the largest interambulacral plates. The interporiferous area has a breadth of exactly one-half the width of the whole ambulacral area, and is furnished with two rows of small mammillated miliary tubercles, that is to say, one tubercle to each plate, which occupies the whole space between the poriferous zone and the median suture, and no granules are present.

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[1] "Proc. Roy. Soc. Edin.," vol. xii., pl. vii., fig. 6.

The interambulacral areas are rather more than four times the width of the ambulacra at their widest part, measuring 8·4 mm., the breadth of the ambulacra being 2 mm. There are two rows of seven and six primary tubercles respectively in each interambulacrum. The primary tubercles are of comparatively small elevation, perforate, and more or less distinctly crenulate on the abactinal side; those near the apex being strongly crenulate; and their mamelons are comparatively large, and almost hemispherical. The scrobicules are wide and transversely oval; the scrobicular ring is incomplete in consequence of confluence with the adjacent scrobicules actinally and abactinally. There are from six to eight small mammillated miliary tubercles on each side, with an occasional small irregularly placed miliary granule here and there, but no other tubercles or granules are present on the plate, and consequently no miliary zone. In a favourable light, traces of faint radiating channels may be detected traversing the scrobicular area on the actinal side of the largest plates. The peristome is subpentagonal, 7·25 mm. in diameter, being about two-fifths of the diameter of the test, or 40 per cent. The buccal membrane is covered with imbricating scales.

The apical system is large, measuring 8·5 mm. in diameter, or in the proportion of 47 per cent. of the diameter of the test. The genital plates are large and broadly shield-shaped. They are united by a rather broad contact, by which means all the ocular plates are shut out from entering the ring. The ocular plates are much smaller than the genital plates, and subpentagonal in shape, and their puncture is near the outer margin. I have not detected a puncture in any of the genital plates. There is, however, a well-defined round aperture amongst the periproctal plates, between the anal orifice, and one of the genital plates. The apical system as a whole is high and convex.

The primary radioles are long and slender, cylindrical and tapering slightly; the longest measures 48·5 mm. in length, and a little less than 2 mm. in diameter. They are finely striated longitudinally, the ridges being very slightly prominent, and marked with very faint and indistinct serrations. There is a short collar above the milled rim, 4 mm. in length, very finely and regularly striated, of a rich chocolate colour, in striking contrast to the ashy-white colour of the rest of the spine. The articulatory rim of the radioles above the ambitus is often strongly crenulate on one side in correspondence with the crenulated tubercle.

The colour of the test in alcohol is of a rich purplish-brown or chocolate colour.

Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

Remarks.—Although this example is probably immature, I feel no hesitation in placing it in the genus *Porocidaris*; it is at once characterized by the strongly crenulated primary tubercles above the ambitus, and by the transversely oval, confluent scrobicules. It is distinguished from the previously described species by the narrow poriferous zones by the small number of the miliary or secondary tubercles on the ambulacral and interambulacral plates, and by the character of the primary radioles. Unfortunately, all the spines have been abraded from the actinal region of the test below the ambitus, and I am not able to say whether any of the peculiarly-toothed, flattened spinelets observed in other forms of *Porocidaris* were present in this species. None of the basal plates are punctured in this example, and I am unable to say, without dissection, whether the aperture amongst the periproctal plates between the anus and the ring of basal plates is in relation to the generative system. I am inclined to think it probable.

3. *Phormosoma placenta*, Wyville Thomson.
   Locality—As last. Depth 750 fathoms.

4. *Phormosoma uranus*, Wyville Thomson.
   Locality—As last. Depth 750 fathoms.

A single fine example which appears to me to accord closely with the figures given by Sir Wyville Thompson,[1] as well as with his remarks, and with those of Professor Alexander Agassiz,[2] upon the species. I have, however, never seen the type.

5. *Echinus microstoma*, Wyville Thomson.
   Locality.—About 56 miles off Dursey Head. Depth 345 fathoms.

6. *Echinus norvegicus*, Düben & Koren.
   Localities.—About 56 miles off Dursey Head. Depth 345 fathoms. Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

7. *Psammechinus miliaris* (Müller), Agassiz.
   Depth 5 fathoms.

[1] "Voyage of the Challenger, the Atlantic," vol. i., pp. 146–149, figs. 33, 34.

[2] Zool. Chall. Exp., part ix., Report on Echinoidea, p. 103; Report on "Blake" Echini, Mem. Mus. Comp. Zool. Harvard, vol. x., pp. 35, 36.

8. *Spatangus purpureus*, O. F. Müller.
   Depth 54 fathoms. ? locality.

9. *Spatangus Raschi*, Lovén.
   Locality.—Off Dursey Head. Depth 345 fathoms.

10. *Brissopsis lyrifera* (Forbes), Agassiz.

    Depth 5 fathoms.
    Depth 54 fathoms.

V.—HOLOTHUROIDEA.

1. *Holothuria intestinalis*, Ascanius & Rathke.
   Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

2. *Holothuria tremula*, Gunner.
   About 56 miles off Dursey Head. Depth 345 fathoms.

3. *Stichopus natans*, Sars.
   Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

4. *Cucumaria hyndmanni* (Thompson), Forbes.
   Locality.—About 56 miles off Dursey Head. Depth 345 fathoms. A single young example, 14 mm. in length.

5. *Thyonidium pellucidum* (Fleming), Düben & Koren.
   Depth 50 fathoms.

6. *Lætmogone violacea*, Théel.
   Locality.—Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

List of Dredging Stations.

The following lists will show at a glance the association of the species at each of the stations (unfortunately the exact localities of several of these have been mislaid):—

1. Long Island Sound. Depth 4 fathoms.
   Antedon rosacea. *Ophioglypha lacertosa.*
   Asterias rubens.

2. Log 2. Depth 33 fathoms.
   Luidia sarsii.

3. Log 67. About 56 miles off Dursey Head. Depth 345 fathoms.

Pontaster limbatus.
Astropecten irregularis.
Brisinga coronata.
Ophioglypha signata.
Ophiobursa hystricis (?).
Dorocidaris papillata.
Echinus microstoma.
Echinus norvegicus.
Spatangus raschi.
Holothuria tremula.
Cucumaria hyndmanni.

4. Log 69. Lat. 51° 1′ N., Long. 11° 50′ W. Depth 750 fathoms.

Plutonaster bifrons.
Pentagonaster balteatus.
Pentagonaster concinnus.
Zoroaster fulgens.
Neomorphaster eustichus.
Pteraster personatus.
Hymenaster giganteus.
Cribrella oculata, var. *abyssicola.*
Porocidaris gracilis.
Phormosoma placenta.
Phormosoma uranus.
Echinus norvegicus.
Holothuria intestinalis.
Stichopus natans.
Lætmogone violacea.

5. Log 70. Depth 5 fathoms.

Ophioglypha lacertosa.
Ophioglypha albida.
Ophiothrix fragilis.
Psammechinus miliaris.
Brissopsis lyrifera.

6. Log 71. Depth 24 fathoms.

Astropecten irregularis.

7. Log 72. Depth 54 fathoms.

Astropecten irregularis.
Stichaster roseus.
Ophiopholis bellis.
Spatangus purpureus.
Brissopsis lyrifera.

8. Log 73. Depth 50 fathoms.

Luidia ciliaris.
Stichaster roseus.
Ophiopholis bellis.
Ophiothrix fragilis.
Thyonidium pellucidum.

9. Localities not recorded.

Psilaster andromeda.
Nymphaster protentus.
Spatangus purpureus.

DESCRIPTION OF THE PLATES.

Plate XXV.

Fig. 1. *Pentagonaster balteatus*, Sladen. Abactinal aspect; natural size.
2. Abactinal aspect of a ray; magnified 3 diameters.
3. Actinal aspect of a ray; magnified 3 diameters.
4. A portion of the abactinal surface; magnified 15 diameters.
5. Adambulacral plates and adjacent portion of the actinal surface; magnified 27 diameters.

Plate XXVI.

Fig. 1. *Pentagonaster concinnus*, Sladen. Abactinal aspect; natural size.
2. Abactinal aspect of a ray; magnified 3 diameters.
3. Actinal aspect of a ray; magnified 3 diameters.
4. A portion of the abactinal surface; magnified 25 diameters.
5. Adambulacral plates and adjacent portion of the actinal surface; magnified 18 diameters.

Plate XXVII.

Fig. 1. *Pteraster personatus*, Sladen. Abactinal aspect, natural size.
2. Actinal aspect; natural size.
3. A portion of the supradorsal membrane; magnified 6 diameters.
4. Adambulacral plates and adjacent portion of the actinal surface; magnified 7 diameters.
5. Mouth-plates; magnified 5 diameters.

Plate XXVIII.

Fig. 1. *Hymenaster giganteus*, Sladen. Abactinal aspect; natural size.
2. A portion of the supradorsal membrane; magnified 5 diameters.
3. Adambulacral plates and adjacent portion of the actinal surface; magnified 4 diameters.

Plate XXIX.

Fig. 1. *Porocidaris gracilis*, Sladen. Profile view; natural size.
2. Actinal aspect; natural size.
3. A portion of the test near the ambitus; magnified 5 diameters.
4. A portion of a primary radiole; magnified 12 diameters.
5. Apical system; magnified 3 diameters.

LIV.

ON THE KILLARY BAY AND SLIEVE PARTRY SILURIAN BASIN, ALSO NOTES ON THE METAMORPHIC ROCKS OF NORTH-WEST GALWAY (YAR-CONNAUGHT). By G. HENRY KINAHAN.

[Read January 12, 1891.]

In a Report published in these Proceedings (2nd series, vol. iii.), and read December 7, 1881, I showed that the Silurians of Killary and Slieve Partry accumulated unconformably, to the more or less metamorphic rocks in the regions to the northward and southward. But this country has recently been visited by Messrs. A. Geikie and Peach, whose statements in connexion therewith are contrary to the facts as stated by me. Some of these have not been printed, but others appear in the "Proc. Roy. Institution of Great Britain," vol. xii., part iii., No. 82, pp. 528, *et seq.*

The printed statements will hereafter be quoted; but previously to doing so we will consider some others relating to the Killary Silurian Basin. It should be mentioned that Dr. Hull's published one-inch maps of the district are rather conflicting, as on them similar rocks and groups of rocks, on adjoining maps, are differently lettered and coloured; in many places the important dips of the strata are left out, or misplaced, or the dip of the cleavage has been substituted; while English group names, inapplicable to the Irish rock groups, are used, thereby adding to the confusion.

The south boundary of this Silurian basin, in general, is more or less complicated, and in places would be hard to determine were it not for the decided difference between the rocks of the two formations. This boundary, however, is allowed to be correct, except to the north of Kilbride Bay, an arm from the S.W. of Lough Mask. But my northern boundary is stated to be a myth, and also the small inlying exposures to the north and south of Killary Bay; while all the rocks from the south boundary northward to Clew Bay belong to one group; the sole difference between my Silurians and my Ordovicians being that the latter are in part metamorphosed.

The Croagh Patrick range and the country immediately south of Clew Bay was not worked by me. But I am aware that the Louisburgh series and the Creggaunbaun series lie unconformably on the older rocks of the Croagh Patrick range; in fact, in the portion of the Creggaunbaun basin that came into my area there is a conglomerate lying unconformably on the upturned edges of the Doolough slates. In this Paper, however, I will principally confine myself to my special work.

North Boundary of the Killary and Slieve Partry Silurian Basin.—To the eastward in the Toormakeady district (Slieve Partry) the Silurians are principally false-bedded massive conglomerates, containing many rounded pieces of granites and other rocks from the country to the south-westward; but they also contain fragments of the rocks in the country to the northward—conspicuous pebbles being those of jasper, found *in situ* in the Aille river valley. Other rocks of the north country—not to be found in the country to the south—that occur in the conglomerate—are fragments of the pebbly sandstones south of Westport and of the quartzose grits of the Erriff valley.

The massive conglomerate of Slieve Partry to the westward is replaced by massive pebbly grits, the conglomerates disappearing nearly altogether west of the Aille river valley; they, however, again appear west of the Doolough valley, but not of the same massive character. Farther west they are very conspicuous on the western flanks of Mweelrea, but more especially near the Atlantic in the Dooaghtry, Dadreen, Doovira, and Uggoal outliers.

Before proceeding further it should be mentioned that in the older rocks to the north there are trap-dykes, conspicuous systems of breaks, and the Erriff quartzose grits, all of which come up to, but never enter, the Silurian rocks.

To the eastward, coming up through the massive conglomerate, are three or four exposures of the older rocks. One, of graptolitic black shales, occurs in the Owenbrin valley, to the south of Toormakeady; two, of baked shales, occur near the village of Partry; and a fourth, of schists, in the hills a little to the westward.

The eastern portion of the northern boundary of the Silurians is more or less obliterated by bog and drift, while it has been broken by upthrusting and other faults; still, in numerous places the unconformability between the older and later rocks is apparent—the first striking obliquely at the other, while the Silurian dip south, away from them at low angles. This is very conspicuously seen south of Tawnyard Lough, where the older rocks strike nearly at a right angle

against the Silurians. Hereabouts the dips on the published one-inch maps are, unfortunately, confusing, as those in the Doolough slates represent the dip of the cleavage, and not the dip of the bedding. In the cliffs to the eastward of Doolough the unconformability is conspicuous; it is difficult of access near Doolough; while to the west thereof the boundary is much obscured by drift and bog, and broken by heaves; but still further westward, especially in the previously mentioned outliers, the unconformability is evident, the conglomerates and sandstones *lying nearly horizontal* across the upturned edges of the old slates.

On account of the boggy nature of the country only a few unsatisfactory actual junctions are exposed; but the conglomerates containing fragments of the older rocks to the north ought to be sufficient proofs. As to the small outliers north and south of the Killary, these are very badly shown on the published maps, as the dips are not given in either the old rocks or the adjoining later ones. However, from the worked six-inch it could have been learned that the rocks of the Doolough series are perpendicular, or dipping at a high angle, while the Silurian dip northward at low angles, from nearly horizontal to 45° or 50°.

The Ordovician exposure between the Great and Little Killaries (Salrock promontory) is bounded to the south by a fault, a downthrow to the south. These Ordovicians, as previously suggested by me, must have been a protruding ridge in the Silurian sea, against which the Silurians were deposited. In favour of this suggestion the fossils, according to Davidson's determination, go to prove that the "Salrock slates," although apparently the highest Silurian groups, was a littoral accumulation. But because there is now a fault in the Salrock Pass, it has been stated that the fossils in the Salrock promontory are not of Ordovician types, but of Silurian types. This is a question not for me, but for palæontologists to determine. Harkness, King, and Baily, who were acquainted with the Ordovician fossils, not only of the Irish types, but of those all over the world, have pronounced them to belong to the Irish Ordovician types. I therefore put more faith in their judgment than in that of observers whose knowledge of the fossil types of the Irish rocks necessarily must be very limited. Besides stratigraphical evidence goes to prove that their (Baily, &c.) determinations are right.

We have now to consider the metamorphic rocks at Kilbride Bay, Lough Mask. These consist principally of gneiss and micalites. Between those on the north of the bay, and the fossiliferous Silurians

more northward, there is either an ordinary fault, a downthrow to the northward, or a thrust plane, up which the schistose rocks were overthrust on to the Silurians. In either case the Silurians must be unconformable to the schistose rocks, as the sandstones of the first are made up largely, if not solely, of the detritus of the latter. Furthermore, the metamorphic rocks, both north and south of Kilbride Bay, are portion of one mass of rock; and as those to the south are ocularly unconformable to the Silurians, it follows that those to the north must also be unconformable.

North-west Galway (Yar-Connaught) *Metamorphic Rocks.*—The statements made by Dr. A. Geikie in his Paper published in "Pro. Roy. Inst. Gt. Brit.," in connexion with these Galway rocks, given in the order in which they occur, are as follows:—

Loc. cit., p. 529.—"The oldest known rocks of Europe, now generally termed Archæan, . . . give rise to topographical features which, when fully developed, strongly distinguish them from all younger formations. Nowhere else can such extraordinary unevenness of surface be found. Knobs, hummocks, and ridges of almost bare rock, separated by narrow gullies or by wider winding valleys, roughen the ground in all directions. In the hollows lie innumerable tarns and lakes, or flat tracts of bog, where lakes once were. In some districts, indeed, there is as much water as land in a given number of square miles.

The statement as to the age of the rocks is so put that hereafter the writer may state that his observation only applied to the age of the British and Irish rocks, although evidently from what is subsequently stated the writer intends to impress on his readers that these Scotch and Irish rocks are the oldest in the world. If such is his meaning, the assertion is highly problematical, as none of the rocks to which he refers have the characteristics of the Laurentian; that is, of the oldest rocks of America at present recognized. These Scotch rocks more probably are equivalents of one of the groups in the *Algonkians* of the U. S. American Geological Survey, or the *Ontarians* of Lawson of the Canadian Survey."[1]

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[1] Logan classified the pre-Cambrian rocks as *Laurentians* and *Huronians*; and Selwyn on his map (published 1885) in a great measure follows this classification, except that the rocks in the ridge extending from Eastern Quebec into Vermont are only called *pre-Cambrian*. Irving classes the pre-Cambrian rocks of the Lake

As to the assertion in reference to the distinguishable topographical features, they may possibly hold good in Scotland, but certainly they do not hold good in Ireland, and far less in America. In portion of the Devonian regions of Cork and Kerry the description given above is applicable, while in portions of the Donegal metamorphic area (none of which rocks Dr. Geikie will allow to be pre-Cambrian) there are topographical features identical with those of the Algonkian district, north of Lake Superior, if we may be allowed to compare small things with great. As far as I have seen in America, Ireland, and Scotland, the most rugged and roughest districts are schist regions, especially if associated with these are large areas of hornblende or allied rocks—while the gneiss and other granitoid-rock regions, in comparison with them, are comparatively tame. As a rule, as far as I saw, the Laurentian regions in Canada are much less rugged than the Huronians and

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Superior Western district (*Classification of the Early Cambrian and pre-Cambrian Formations, U. S. Geological Report*, 1885 *and* 1886) as follows:—

Systems.	*Groups.*
Palæozoic, ...	Carboniferous. Devonian. Silurian. Cambrian (Lower Silurian).
Agnotozoic, or Eparchæan, . . .	Keweenawan. Huronian. Other groups.
Archæan, ...	Laurentian, including Upper Laurentian.

Although this classification has been published in the U. S. American Official Reports (1885-86), I learn from Professor Van Hise that for Agnotozoic the Survey has now substituted the territorial name *Algonkian;* while Dr. Lawson, of the Canadian Survey, states that his name *Ontarian*, as it had a priority, ought to be adopted.

As to the term, Archæan, Irving, in his Table, restricts it to Logan's Laurentian; but Dana, the originator, in a letter to me states that he originally proposed it to include all the American pre-Cambrian strata. At the same time he points out that recent researches might modify its full original scope; because the organic remains found in the Nova Scotian pre-Cambrian rocks and the supposed organic remains in the Penokee Gogebig iron region (Huronian) would in a measure make it inapplicable.

The Scotch and Mayo rocks referred to by Dr. A. Geikie, as far as my experience goes, are in general characters very similar to the East Quebec and Vermont rocks (*Algonkians*) and those of the Lake of the Woods series (*Ontarians*); and if these are the equivalent of the Scotch and Mayo rocks, the European rocks are far from being the oldest known, as there is a profound break between the Algonkians and the Huronians, and a second between the Huronians and the Laurentians.

Ontarians. Any one driving through Connemara, or overlooking it from the Twelve Pins (Bennabeola), can easily tell which hills are granitic gneiss and which are schist; the same holds good in Canada, except that on account of the timber these rugged characters are in part blinded. The timber, to a novice, is at first puzzling; but I suspect that to those used to the country it would not be so, as there are marked characters distinguishing the vegetation on the different strata.

Loc. cit., p. 530.—"These various rocks were eruptive—that is, that they originally formed portions of igneous materials that rose in a molten or plastic condition from below can hardly be doubted."

Same page.—"Nowhere in the region to which I am referring has any trace of superficial eruption yet been detected. Not only so, but after the most careful search from Sutherland to Galway, not a vestige have we found of any unquestionable sedimentary materials. There are no conglomerates, no sandstones, no shales, not even any materials that might be supposed to represent them in a metamorphosed condition."

To the statements in the two above extracts I cannot agree.

The discoveries of Lapworth and others in North-West Scotland are most important, and hereafter will materially assist in the correct mapping of all metamorphic rock areas, but unfortunately those working at the rocks are so blinded by the shearing discovery that they believe that shearing, and only shearing, is the main cause of metamorphic action. Those, however, who study metamorphism rationally, must be aware that, although shearing is a very important action, yet that it is only an adjunct to as great, if not greater, changes.

The statements made in connexion with the "hornblende rocks" of Macculloch (diorite, syenite, &c., of other writers) illustrate the above.

The normal hornblende rocks of Pennsylvania (as described by Lewis and Williams)—those of Ontario, Canada—of Wexford, of Galway, of Donegal, and elsewhere in Ireland—and of Sutherland, Scotland—graduate into nodular varieties, and the latter into schistose rocks, often nodular, the nodules having been called by the Scotchmen "eyes."

The nodular varieties sometimes are found margining masses of the normal hornblende rock; but more usually they occur at the ends of the long courses. The schistose varieties, called by me in previous writings *hornblendites*,[1] if the nodular varieties are absent, margin the normal

[1] Dana makes the term hornblendite to include all the hornblendic rocks. After a correspondence on the subject I am led to believe that his use of the term is better than mine. It is, however, expedient to give my original definition of the term as used in my maps and writings.

rock; while in other cases the nodular varieties graduate into them. The nodular varieties in general have a hornblendic matrix, but not always so, as in places the matrix may be felspathic. The schistose varieties belong to two distinct classes. If they occur at the upper or lower margin of a course of the normal rock, they are evidently a portion of the mass that has acquired their foliation from some special cause; but if they occur in continuation of a course, especially if they are adjuncts of the nodular varieties, originally they had more or less of a sedimentary origin. Nearly invariably they contain "eyes," and graduate longitudinally into other varieties of schist, or into conglomeritic-schists and gneiss, which may be micaceous or felsitic or even quartzitic. The "eyes" usually are hornblende rock, but often are not.

Some ask us to believe that all these varieties are solely due to difference in the shearing process, as the rock, originally, was one intrusive mass, and of this, the normal hornblende rock represents the untorn-up portion, while the nodular and schistose varieties represent the original in different stages of reconstruction. Before, however, this is believed, it seems necessary that they should explain how in places the matrix of the nodular varieties are micalites, felsilites, or even quartzites? and how so many of the "eyes" in the schistose varieties of the second class are of foreign rocks? Also why these adjuncts to the normal hornblende rocks have characters so similar to those of the adjuncts of whinstones in unmetamorphosed area? and even to the adjuncts of the recent volcanic rocks? This last question we will now demonstrate.

Unmetamorphic Rocks.—In the Ordivicians of Dublin, Wicklow, Wexford, and Waterford,[1] the courses of whinstone nearly invariably have shaly margins, while often they graduate into nodular varieties, and in some places, as can be ocularly proved, an intrude is in part a whinstone and in part an agglomerate or tuffoid rock. In the *Volcanic, or Ballymoney series*, Co. Wexford, some most interesting changes take place, the normal whinstone graduating into a tuffoid rock or agglomerate, often calcareous, and thence into shales and limestones.

[1] No correct maps of this district are published. Jukes condemned the early survey, as for the most part it was a rough traverse made by W. W. Smyth, Dela Beach, Oldham, &c., as can be learned from their maps. The portions so loosely surveyed he ordered to be re-surveyed by Du Noyer. The survey and descriptions of the latter were not approved of by Jukes; but eventually, when pressure was put on him the maps were published; but they were considered by Dr. Hull to be so incorrect that I was deputed to revise them. My maps were approved of by

In the Silurians (*Lower Old Red Sandstone type*) of Cork, Kerry, Mayo, Roscommon, Tyrone, &c., there are masses and courses of eurite that have shaly margins, and that graduate in places into conglomeritic and tuffoid rocks; while in the Devonians of Cork there are whinstones that have similar peculiarities. In Limerick and Cork there are shaly margins, and in places breccias as adjuncts to the Carboniferous whinstones, while the Eocene whinstone of Antrim has these associated tuffs and conglomerates, which are conspicuous at the volcanic centre, near Carrigarede, Co. Antrim. If the rocks of the Carrigarede district were metamorphous the results would, I believe, be rocks representing all the stages of the so-called "Old Boy" of Sutherland.

In connexion with the more recent volcanic rocks, Cotta mentions the marginal brecciated stuff which he calls "friction breccia"—such adjuncts are also described by the American geologists, by Admiral Smythe, in Teneriffe, and by Valentine Ball, in India—the latter exhibiting models of some of them in the new Science and Art Museum, Dublin.

From the foregoing it is evident that in Ireland alone—and probably in numerous other places with which I am not personally acquainted—whinstones and the allied eurites, have as adjuncts shaly and conglomeritic varieties similar to those that in metamorphic regions are nearly universally the adjuncts of the masses and courses of hornblende rocks. Why, therefore, should not these adjuncts in both the altered and unaltered rocks have the same origin, instead of drawing in shearing to account for them in the metamorphic areas?

Dr. Hull, in consultation with Sir A. C. Ramsay. So much so, that the major portions of four of the inch sheets were ordered to be obliterated by the Ordnance Survey, and one (Sheet 148), at least, was re-engraved. My work, however, was in its turn condemned by Dr. A. Geikie, who stated that Du Noyer's work was more correct. Yet if the ground is examined, on my six-inch working maps every rock-exposure visible, while I was in the country, is mapped, and from the information thus obtained my one-inch maps were prepared. On the only maps now procurable by the Public all the inaccuracies of the early traverses and the subsequent re-survey are to be found. Consequently, they are more calculated to mislead than enlighten the public. Who can find on them the beds of iron ore in the Co. Wexford? or the whinstones quarried for paving sets in the Co. Wicklow? Or where on the ground will be found the granite in many of the places so marked on the maps? also, who can make the descriptions in the memoirs to agree with the maps? Map sheet 158 represents the old survey, while the published description is that of my condemned work. Similarly, the revised memoirs of sheets 138, 139, 148, and 149, by Messrs. Hull, Hardman, and Cruise, do not tally with the published maps.

The absurdity of the latter to me is self-evident, as can be ocularly proved both in counties Wicklow and Donegal, as in these areas you find, in the metamorphic rocks, courses that have a central hornblendic gneiss, or hornblendic rock rib, with schistose margins; while these courses, when traced into the unmetamorphic areas, are found to have a diorite, diabase, or allied rock rib, with tuffoid margins. In the counties Galway, Mayo, Wicklow, and Wexford, I have found whinstones and eurites passing gradually into conglomeritic or fine tuffs; and the latter into sedimentary rocks; the graduations being so imperceptible as to defy the most acute observer to say positively the exact places where one class of rocks ends and the other begins.[1]

Consideration.—In unmetamorphosed regions, in connexion with intrudes, there are the "Baked rocks." These are, for the most part, *granulites*, *leptinites*, *hornstone*, and such like felsitic rocks.

Associated with the "Untorn-up," "Old Boy," of Sutherland, Scotland, the hornblende rock in the older metamorphosed rocks of Ireland, and the hornblende rocks in the Ontarians of Canada, there are highly felsitic gneissose rocks. It may be asked what brought them there? and what was their origin? I would suggest that in all these situations originally they were "Baked argillaceous rocks" that subsequently were metamorphosed.[2]

Of course, in metamorphic regions the shearing has modified the original structure, and indeed in places where it was intense, obliterated them; because, as pointed out by myself and others, in the granitoid gneiss the foliation becomes perpendicular, or nearly so.[3]

Furthermore, in all conglomeritic rocks, foliation, and, in general, even cleavage, changes the outlines of the inlying pebbles, elongating them more or less. I could point out in the county Donegal granite pebbles, adjoining an upthrust place, that have been elongated to an extraordinary extent; while in the layers immediately above, the pebbles are in their normal state. Wyley and Haughton long since

[1] The Great Rock, Arklow, county Wicklow, is one of these puzzles. Of it there are in existence maps by Oldham, Smythe (?), Jukes, Du Noyer, and myself, in none of which is the mapping the same; while in some of them the rock classification is most different.

[2] In fact, in places in the Co. Wicklow it is self-evident that some of these "Contact gneisses" were originally "Baked rocks."

[3] From my own experience, and from the writings of others, I at one time considered this to be an unexceptional rule; but recently in the Malin promontory, Innishowen, Co. Donegal, I have found granitic gneiss in which the foliation is nearly horizontal.

pointed out the elongation of pebbles and fossils due to cleavage in the Carboniferous rocks in the county Cork.

In all coarse fragmentary accumulations, from the Cambrian and older conglomerates, up to the drift forming at the present day, it is found that fine argillaceous or arenaceous sediment has a tendency to curl round any inlying blocks or fragments. If, therefore, in any such accumulations there was a subsequent metamorphism, the foliation induced by the primary structure would be similarly curled. But of course any subsequent shearing would more or less elongate the original curling or spheroidal structure.

That the statements above abstracted from Dr. Geikie's paper are erroneous in connexion with the county Galway will hereafter be shown; but previous to doing so it is expedient to give a *résumé* of what we learned in Scotland.

During our stay in Sutherland we saw some undoubted valuable discoveries; but at the same time we were asked to believe statements for which no proofs could be shown.

We were asked to believe that the pre-Cambrian schists, called by them "Old Boy," were originally massive intrudes of diorite or allied rocks; and that their present apparent stratification is solely due to reconstruction; that is, attenuation caused by shearing, which tore up the masses of igneous rocks, and left the materials in their present apparent stratified order. No positive proofs in favour of their assertions were, however, forthcoming; on the contrary, all the facts we could be shown were calculated to prove that the assertions were wrong.

In the "Old Boy" there are the masses and courses of hornblende rock (Maculloch—but called by them by some new name) said to be the untorn-up portions. These, however, graduate into nodular and schistose varieties, which, as already demonstrated, suggest that this tearing up is more imaginary than real; the masses and their adjuncts having similar relations to one another as those of the whinstones and their adjuncts of Ordovician age in the counties of Wicklow and Wexford, where the rocks have been subjected to very little alteration from either shearing or molecular change.

These advocates of the origin of their "Old Boy" would like to ignore the facts that in the different areas there are considerable tracts that are highly quartzitic (*micaceous or gneissose quartzite*) and others that are very felspathic (*felsitite and micaceous felsitite*) rocks that by no process of shearing, or by no molecular, or by no chemical change, could be reconstructed whinstone. These difficulties, however, they tried to get over by saying that, associated with the original masses of

whinstone, there were felstones and quartz rocks; but curiously, although they can show you the so-called "untorn-up whinstone," they never could show the untorn-up felstones or quartz rocks.

In the Sutherland, Ross, and Cromarty "Old Boy," similarly as in all other tracts of metamorphosed rocks that I have examined, in the Old and New World, there are metamorphosed dykes more or less transverse and crossing the general structure (*stratification?*) of the County Rocks. Invariably the foliation in these dykes has strikes and dips quite distinct to those of the associated rocks. This to me is a simple phenomenon, because, as pointed out years ago by David Forbes, foliation is induced by the most prominent original structural planes. Here, therefore, we have in the County Rocks the foliation induced by the most prominent original structure, let it be cleavage, lamination, &c.; while, in the dykes, it was induced by their most prominent structure, which, in general, is more or less parallel to the walls of the dykes. Such simple explanation, will not, however, be allowed by "the sh earers," as they insist that the foliation in the County Rock is due to a shearing force coming in one direction, while the foliation in the dykes is due to a subsequently shearing force coming in another direction; but they fail to explain how the latter force confined itself solely to the dykes, the walls of which are still intact.

Before making such sweeping assertions they should visit such regions as that of Lake St. John, Eastern Quebec, or even the Lough Conn district, N. E. Mayo, Ireland. In both these widely-separated places the latest foliation seems to be in the main due to shearing. And its strike, let it be in granitic rocks, in hornblende rocks, or in schist or gneiss, is always in one direction, although its dip in places may slightly vary. In contradiction to the general theory of "the shearers," it may be pointed out that in these excessively altered rocks, some of the leaves in the Norians of St. John's being over 3 feet long, the boundaries of the intrudes have been very little distorted. In the St. John's district it is quite easy to trace the boundary of the Norian and the dykes from it; while in the Lough Conn district, Co. Mayo, the boundaries of the granite courses in the gneiss and the boundaries of the masses of hornblendite that occur as inliers in the granite, are nearly intact, they only being a little serrated.[1]

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[1] In the granite north of Galway Bay there are some dykes of a rock that must be called "typical schist." The walls of these dykes are regular and well-defined. On the other hand, in the rocks of the Letterkenny district, county Donegal, which are only sub-metamorphic, shearing has played queer pranks, drawing out tongues

A primary and universal shearing is not found in the normal "Old Boy" of Sutherland, Ross, and Cromarty; for in the space of a few yards the direction of the strike may change two or more times, while the dip is so variable that to me it appeared that the foliation could not have been generated by a shearing force coming in one direction, as is stated; but that it was induced by previous structures. If so, *each change in the direction of the strikes and dips suggests different original beds of rocks, and not an uniform origin, due to the tearing up of a mass of intruded rock.*

From what I have learned elsewhere, in metamorphic and sub-metamorphic territories, I am convinced that the general metamorphics of the "Old Boy" of Sutherland, Ross, and Cromarty, took place at one and the same time; that is, that the general metamorphosis of the County Rocks and of the associated dykes was simultaneous; the foliation in the first being induced by their different prominent structures, and those in the dykes by theirs. This seems to be ocularly proved, especially in the latter, where the foliation has all the variations that will be found in the structure of unaltered dykes. As to the County Rocks, I will not hereafter be surprised to hear that on the surface of some of the quartzites elongated ripple-marks will be found, as in my hurried visit I saw marks very like such.

We were also shown dykes that are of greater or less width when crossing the County Rocks, but that lessen considerably in the fault lines (*upthrusts*); this lessening being said to be due to their being drawn out by the thrusting along the faults. Possibly this may be the case; but as a general rule, *dykes crossing strata are better developed than when running along it, or along lines of fault.* This can be seen in connexion with the dolorite dykes in the Carboniferous slate of county Cork, and the dolorite dykes in the metamorphic and granitic rocks of Galway, Mayo, Donegal, &c., their make being very similar to that of a metalliferous vein, which are usually well-developed lodes when crossing the County Rocks, while they may be mere leads when the veins take to follow the bedding.

In connexion with the dykes, it may be mentioned that we were shown "whin sills" that were said to be "undoubted intrusive sheets." Curiously, however, each had its own *special* geological horizon; and

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of shale, sandstone, and limestone, so that now the different classes of rock, although very little altered, are very conspicuously interlaced—sometimes this is on a large scale; on a small scale it can be seen in a limestone quarry at Kiltoy, N. E. of Letterkenny.

no matter where you went, if you came to any particular horizon, there also was the "whin sill." In places we were shown that they crossed the strata; but this must occur with all contemporaneous sheets; as it is nearly unnecessary to point out that a rock coming up from below must cut across all rocks below its geological horizon. *None of these sheets, however, cut up into the strata above their horizons.*

In support of their assertions in connexion with their "Old Boy," "the shearers" pin their faith very much on the peculiar "Moine or Eastern schists." These schists undoubtedly are most remarkable rocks, but in connexion with them we were asked to believe far more than could be proved. The "Moine schists" are said to be attenuated or torn-up "Old Boy," "Torridon sandstone," "Pipe quartzite," and "Durness limestone."

We were shown the "Old Boy" passing into these schists; we were also shown the basal bed of the Torridon sandstone passing into a rock very similar. This locality is worthy of special notice. The basal conglomerate lies on the "Old Boy," and both are changed into rocks that might be called "Moine schists." *But the tearing up is not what ought to be expected, as the boundary between the rocks of the two distinct periods is nearly intact, only being a little serrated.* Considerable portions of the Moine schist are quartzose rock, that possibly may be attenuated pipe quartzite, while we were also shown the Durness limestone becoming attenuated; but our instructor totally failed to show us in the "Moine schist" any rocks that could represent the torn-up Durness limestone. We were told we could see it in the Loch Maree district, but when we went there, we found this supposed torn-up Durness limestone to be an intrude of calcareous whinstone.

Connemara District.—From the already given quotation from the Paper of Dr. Geikie, we learn that he and his assistants have proved that my conclusions are wrong. As Dr. Geikie refers to an area in which, as far as he saw it, all the rocks are metamorphosed, he is so far safe in saying that there are "no conglomerates, no sandstone, no shales," as all that he saw have lost their normal characters. This, however, may not be the case with rocks he did not see further southward, in Goroman and Lettermullen. However, his statement, that *not even any materials that might be supposed to represent them also in a metamorphosed condition occurs*, is perfectly incorrect.

His statements as to the metamorphosed fragmentary rocks are quite at variance with those of the scientists who have made such rocks their special study. Even in Sutherland the altered and attenuated Torridon conglomerates have characters in common with those of the

Connemara conglomeritic schists and gneiss. Similar metamorphosed conglomerates occur in Mayo, Sligo, and Donegal, while Irving, Van Hise, &c., have described them in various places in the Lake Superior regions, especially in the Marquette district, and other places in Wisconsin and Michigan.

The schists, gneiss, and granitic rocks to which the statements apply, lie principally in the tract bounded to the north by the road from Clifden to Oughterard, and from thence extending southward to Galway Bay. A brief epitome of the rocks found therein may be given.

Granitic and schistose rocks herein are found, the first consisting of granites and gneiss. The granites are at least of three distinct types, called by me, in previous publications, *Galway type*, *Omey type*, and *Oughterard type*. The Oughterard and Omey types are evidently newer than the Galway type, with its associated gneissose and schistose rocks. As elsewhere demonstrated, the Galway type granite graduates into gneiss, and from it into schists, the latter, apparently, merging into the unaltered Ordovicians. Northward, in the Letterfrack and Kylemore district, there is a *fourth type* in the lacoliths of the Silurian eurites, while still further north, in the barony of Murrisk, county Mayo, there is a *fifth type* (Corvockbrack granite), which is probably of Devonian or even Carboniferous age.

The latter statement, however, cannot be positively asserted, as, between the mass of the Connemara schists and the Ordovicians north of the Killary valley there is an overlying Silurian basin, under which there may possibly be an unconformability.

The Galway type granite I have also called *metamorphic granite*, as the mass to the south-east, although without any structural planes, graduates northward through gneiss into schists, there being no hard boundaries, so that you cannot say exactly where you have left the granite and got on the gneiss, or where you have left the gneiss and got on the schist. This obscurity is specially apparent in connexion with the small isolated granitic tracts, in the schist area, to the southward of Glendalough and adjoining lakes. Westward, however, the main mass of the granite has, in general, a hard boundary, this being due to intrudes of the Omey type coming up between the granite of the Galway type and the schists in the country to the west.

As elsewhere stated by me, although I could not satisfactorily prove it, the metamorphic granite and its adjunct, the granitic gneiss, seem in their present characters—as granite and gneiss—to be newer than the associated schists. That is, the metamorphic action that

altered them into granite and gneiss was in force at a later time than the general action that metamorphosed the County Rocks—or in other words, there were two periods of metamorphic action, one being general, while the later was restricted in its area. In the county Galway I saw no distinct facts to lead to such a conclusion, but in north-east Mayo, where the rocks are very similar, proofs were forthcoming; while, if we go further north into the county Donegal, it can be ocularly proved that the granite, with its associated gneiss, is nearer than the associated schists.[1]

Both in Galway and Donegal, at the southern margins of the granite tracts, there is a bedded-like structure; that is, the granite consists of bedded-like masses, each of which has a more or less distinct appearance and composition, while northward, in both areas, the change from the granite through the gneiss into schists is gradual. This is more marked in Donegal than in Galway, as in the first the area is divided into two, by the great Glenbeagh fault, northward and southward of which this triple system is found.[2]

That the Galway rocks, south of the Clifden and Oughterard road, are for the most part metamorphosed sedimentary rocks appears to me self-evident. The reasons for this assertion will first be given, and subsequently I will reiterate my former reason for supposing that they are younger than the rocks of the Bennabeola (*Twelve Pins.*)

To the extreme north of the area now under discussion in the neighbourhood of the lakes (Ballynahinch, &c.), of the Clifden and Oughterard valley, there is a limestone and schist series in which are subordinate quartzite. This series occurs in all the different sections, and can be traced for miles, although shoved northward and southward by numerous faults. It is scarcely possible to believe that this constant relation of one bed to another could be due to anything but original deposition. No attenuation due to shearing could give similar results; no process of shearing, even if aided by molecular changes, could have

[1] In Donegal, as in Galway, the granites are of different ages. There is the granite, the adjunct of the granitic gneiss—two distinct granites newer than the gneiss, but pre-Ordovician; and a post-Ordovician granite, much newer than the others; as the veins and elvans from it, in the Dunfanaghy district, are newer than the upthrusting and other faults of that area.

[2] Similarly, in S.E. Wexford, we find in the Saltees, bedded-like granite, while to the northward, at Carnsore, the granite graduating into granite gneiss, and the latter into schists. These Wexford rocks, as I have previously pointed out, are probably pre-Cambrian; that is, they represent one of the groups belonging to the Algonkians of the United States American Survey.

separated, out of an original mass of igneous matter, all the different constituents, and placed each as they are now found in regular order for miles. Shearing in combination with its adjuncts might have separated the constituents; but if so, they would occur in spots, but not in continuous beds miles in length. On the other hand, if the argillaceous, calcareous, and arenaceous matter were successively accumulated, and afterwards metamorphosed, we should find successive strata like those in this series of beds.

The similarity of the order in the different sections is the more conclusive when we take into consideration that the continuation of the original beds has received rough treatment, they having been broken and shoved about by heaves, upthrusts, and other faults.

The present structures in the metamorphic limestones seem also to suggest to me that originally they were ordinary accumulations.[1] In many limestones there are both cherty and shaly layers, while disseminated in all limestones there are impurities in a greater or less degree. These impurities, when the rock is metamorphosed, must be concentrated along the lines of foliation. The structures in limestones have characters of their own, evidently due to chemical and molecular changes that began from the time the rocks began to accumulate. This is evident if we study artificial limestone, such as the plaster on a wall, or a dead barrel or sack of cement that has been allowed to spoil and become stone. To the structure in old plaster my attention was first called by Mr. A. B. Wynne, who pointed out that when it was exposed to atmospheric influences, and had weathered, it had characters similar to limestone. In it were lines like bedding, indicating the top and bottom of each course put on by the plasterer, a spheroidal structure due to the plasterer working his implement round and round, opposite to where he stood, while to the right and left there were inverted curves in different directions, due to pushing the implement in opposite ways, and then drawing it back again. These different motions must have more or less separated, imperceptibly, the constituents of the mortar, the lines of separation afterwards being better developed by molecular and chemical changes.

A study of dead cement, whether in barrels or sacks, if followed from the filling to the time it spoiled, is very instructive. The barrels or sacks may have been filled with the shovel, or by a continuous supply from a shoot. But in either case, after each is filled, it is shaken

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[1] I do not exactly conceive how, on the shearing hypothesis, one would account for limestone beds in the torn-up eruptive rocks.

up to consolidate the materials; while subsequently, during carriage, the materials are again shaken. Usually during the erection of any large structure some barrels and sacks of cement are "spoiled"; that is, become stone, and under such circumstances in them are developed structures similar to those found in limestones. In a barrel filled with the shovel there are layers, in each of which there are more or less oblique and spheroidal structures, due to the shakings; and in all is an irregular cleavage due to shrinkage. Sacked cement has in general only a spheroidal structure, with lines that seem to be incipient cleavage.

In many ordinary limestones, but invariably in metamorphosed limestones, there are similar structures; but in the latter usually they are much modified on account of the vicissitudes the rock has undergone. In the natural limestones there are also the silicious and argillaceous layer and parting of the original accumulation; but in old plaster and dead cement any partings, or traces of partings, must be due to the leaching out of the non-limy materials.

Such irregular structures in the metamorphic limestones are claimed to be the result of shearing and upthrusting. Why so I cannot conceive, when similar structures are conspicuous in unsheared rocks. In the metamorphosed rocks, however, such structures ought to be much more conspicuous, as leaching out and other molecular changes, necessarily, would considerably augment and develop them. Upthrusting would tend to make the contortions more prominent, while the shearing in places would break up the continuity of the layers and parting, leaving the remains scattered about in the limestone. The latter often have an appearance like inlying pebbles of chert and mica schist; for which, by some observers, they have been mistaken. There are also the nodules and lentils of endogenous granite, that have been said to be inlying pebbles by some; and by others, portions of veins broken up by shearing. They, however, never were either, having all the characters of pegmatite or endogenous granites.

The above structures are more or less conspicuous in the metamorphic limestones south of the Clifden and Oughterard road, while a little north of that road, about a mile and a-half north-east of Clifden, near Lough Cashleen, in very slightly altered limestones, there are layers and nodules of chert similar to those found in ordinary Silurian and Ordovician limestone.

The well-known Connemara serpentines (*ophiolites and ophicalcites, &c.*), all of which occur in the country north of the Clifden and Oughterard valley, are stated to have originally been pickrites, or an

allied rock. Possibly this may be correct; but if so, there have been very complicated changes, as the original eruptive sheets first became dolomites and dolomitic limestones, prior to changing into the "Connemara serpentines." This last change can be ocularly proved in different places, but especially in the Lisoughter marble quarries.

The tracts and courses of diorite and hornblende rock associated with the limestone of the Clifden and Oughterard valley, but more largely developed in the schist of the country to the southward, are stated to be the untorn-up portions of the igneous rocks that originally occupied the entire area; they having escaped the shearing and attenuating that tore up and reconstructed the associated rocks. The improbability, if not the impossibility, of such a change, has already been considered (*ante*, p. 710).

The rocks of the Bennabeola and adjoining ranges were considered by me (as stated in previous publications) to be the oldest rocks in the region. The recent researches of the American geologists in the metamorphic rocks of the Lake Superior district have, however, illustrated how easy, in metamorphosed and disturbed regions, unconformabilities may be passed over; and how masses of strata, belonging to quite distinct periods of time, may be classed together as portions of one series.

It is therefore quite possible that my determination as to the classification and age of the Connemara rocks may be incorrect, as under the Silurian basin of Killery Bay there may be an unconformability, the rocks to the northward being younger than those to the southward;[1] also the Conga lake conglomerate may also indicate a second unconformability, now not very conspicuous on account of the evident inverted folding. The Conga Lough conglomerate may, however, possibly be, as I formerly supposed, the equivalent of the pebbly quartzite north of Erriff, county Mayo.

Nevertheless, there are still reasons for supposing that my original classification may possibly still be correct. Because, as shown in the original Paper, read before the Academy, if we take the rocks of the Bennabeola, as the lowest in the sequence, and go northward to Clew Bay, county Mayo, eastward to Loughs Mask and Corrib, and south-

[1] The black graptolitic shales of the Owenbrin valley are remarkable, nothing like them being found in the adjoining portion of Co. Mayo. The black schists, however, immediately in the neighbourhood of Galway town, and the black hornstone of Gorumna Island, north of Galway Bay, are, however, rocks that originally might have been black graptolitic shales.

ward to Galway Bay, we find northward, eastward, and southward, a remarkable similarity in the order and characters of the successive groups of strata.

One thing, however, appears self-evident, which is, that *the "Lough Conga conglomerate" belongs to a more recent age than the rocks of the Bennabeola range,* as fragments of the latter rocks occur in the conglomerate.

As the metamorphic rocks of West Galway are of uncertain age, I would suggest that hereafter they be referred to as *Connemarians,* being so well developed in that region; and that the rocks of the Slieve Patrick District, south of Clew Bay, should similarly be named after the territory, and be called UMALIANS.

The *Connemarians,* in lithological characters and grouping, are very similar to the metamorphic series of Perthshire, Scotland. I, however, now put very little faith in lithological characters, as they have been proved valueless in the Lake Superior district; also in the county Donegal. Groups, however, may be of more value; yet, at the same time they are not positive proofs. The very peculiar fine conglomerate, or pebbly grits (near Knappagh, five miles south-west of Westport), in connexion with the Erriff valley quartzose grits, have no counterpart in the *Connemarian,* except that possibly, as just mentioned, they may be the equivalents of the Lough Conga beds. But the pebbly beds in the hill immediately south of Westport are in aspect identical with the Mullaghsawnites of Donegal. These here *lie above* the serpentine range, while to the west, apparently *below* the serpentine range, are pebbly rocks, but more of the nature of a typical conglomerate. As in Donegal, Tipperary, Clare, and Perthshire, the Mullaghsawnites are found on slightly different geological horizons; I would therefore suggest that the pebbly sandstones in the hill south of Westport, and the conglomerate in the Croagh Patrick range, may possibly be related one to another, more especially as the serpentine was originally a trappean overflow.

[SUMMARY.

Summary.

Creggaunbaun and the Killary or Slieve Partry Silurian Basins.

The statements in reference to these rocks are :—

1st. All the rocks between the Killary and Clew Bay, county Mayo, belong to the Silurians. My *Umalians* (Croagh Patrick and *Doolough series*) being sheared Silurians, and consequently that my boundaries are myths.

2nd. The green slates in small exposures to the north of the Killary and in the Rossroe promontory are also Silurians.

3rd. The fossil evidence proving that the *Umalians* are equivalent to the Ordovicians is valueless, as the fossils have been wrongly determined.

4th. The gneiss and schist north of Kilbride Bay, Lough Mask, are only a sheared portion of the fossiliferous Silurians to the northward.

My replies are :—

1. The Creggaunbaun series can be distinctly seen lying unconformably across the upturned *Umalians* in different places; while the Silurians between Lough Mask to the east and the Atlantic to the west, in various places in connexion with their northern boundary, strike more or less obliquely to the *Umalians;* they all dipping southward at low angles, while the *Umalians* are from vertical to rolling at low angles; also the basal conglomerates and pebbly grits contain more or less *débris* of the rocks in the country to the northward; also the traps and faults so numerous in the *Umalians*, although they come up to the northern boundary of the Silurian basin, never enter it.

2. The green slates in the small patches north of the Killary, stand at high angles, while the overlying Silurian dip north at low angles. The green slates in the Rossroe promontory are evidently brought into their present position by a down-throw, to the northward, fault, as can easily be proved if this fault is traced eastward into Slieve Partry.

3. The age of the *Umalian* fossils was determined by such authorities as Harkness, W. King, and W. H. Baily, after years of study of the Ordovician types, of not only Ireland, but of the world.

4. The gneiss and schist north of Kilbride Bay is brought into its present position by a fault, probably an upthrust. The fossiliferous rocks to the northward are largely made up of their *débris*; also this

tract is evidently a detached portion of the gneiss and schist to the south of the bay, and the latter evidently is covered unconformably by the Silurian.

In connexion with the metamorphic rocks of Connemara (north-west Galway), the statements of Dr. A. Geikie are "not proven."

The rugged aspect which is intimated as to be solely characteristic of the "most ancient regions of the world," is not so. It also occurs nearly invariably in all regions of metamorphic ingenite rocks, no matter what was their original age; while, even in Ireland, and more so in America, there are regions in unmetamorphosed rocks that have very similar aspects. As to the "most ancient regions of the world," one is, probably, the Laurentian Hills, which are tame compared with some of the areas in the Huronians and the Ontarians.

The Connemarians were not "most carefully examined," as the most important places were not visited.

The statement that there are no proofs of the metamorphism of older accumulation in Connemara is misleading.

In the conglomeritic gneiss and schist of the area south of the Clifden and Oughterard road, there are indisputable proofs that the rocks originally were accumulations derived from the denudation of older strata.

The subordinate quartzites in the schists of this tract were evidently originally sandstones; in some places even the original fragments are intact.

In the same area some of the argillaceous rocks, especially in the archipelago north of Galway Bay, retain in a great measure their original sedimentary characters.

In one place a little north of the Clifden road the limestone is scarcely changed, it containing the original chert layer and nodules.

There are good reasons for supposing that my original classification of the groups of these metamorphic rocks is correct, because northward, eastward, and southward, from the Bennabeola range of hills, are found successively very similar groups of strata.

On the other hand, however, the recent American work in the Lake Superior region has illustrated how deceptive may be the most careful grouping of metamorphic strata in an entangled area. It is thus expedient now not to be too positive. Indeed, it is possible that there may be a concealed unconformability under the Killary Silurian basin, while the Lough Conga conglomeritic zone may point to a second. The *Umalians*, however, by their fossils, are proved to be the equivalents of the Ordovicians, while the Lough Conga conglo-

merate must be of much later age than the Bennabeola rocks, as fragments of the latter are found in it.[1]

The discoveries of Lapworth and others, in connexion with shearing and upthrusting, are of the greatest importance, especially to a worker in a metamorphosed rock region; but they must be used within their legitimate limits. If, however, as some seem inclined to do, an attempt is made to make them override all the more important adjuncts of metamorphism, then it is attaching to them too great an importance.

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[1] The late Mr. Hardman in his description of similar metamorphosed rocks, county Sligo, specially points out that they contain fragments of older rocks.

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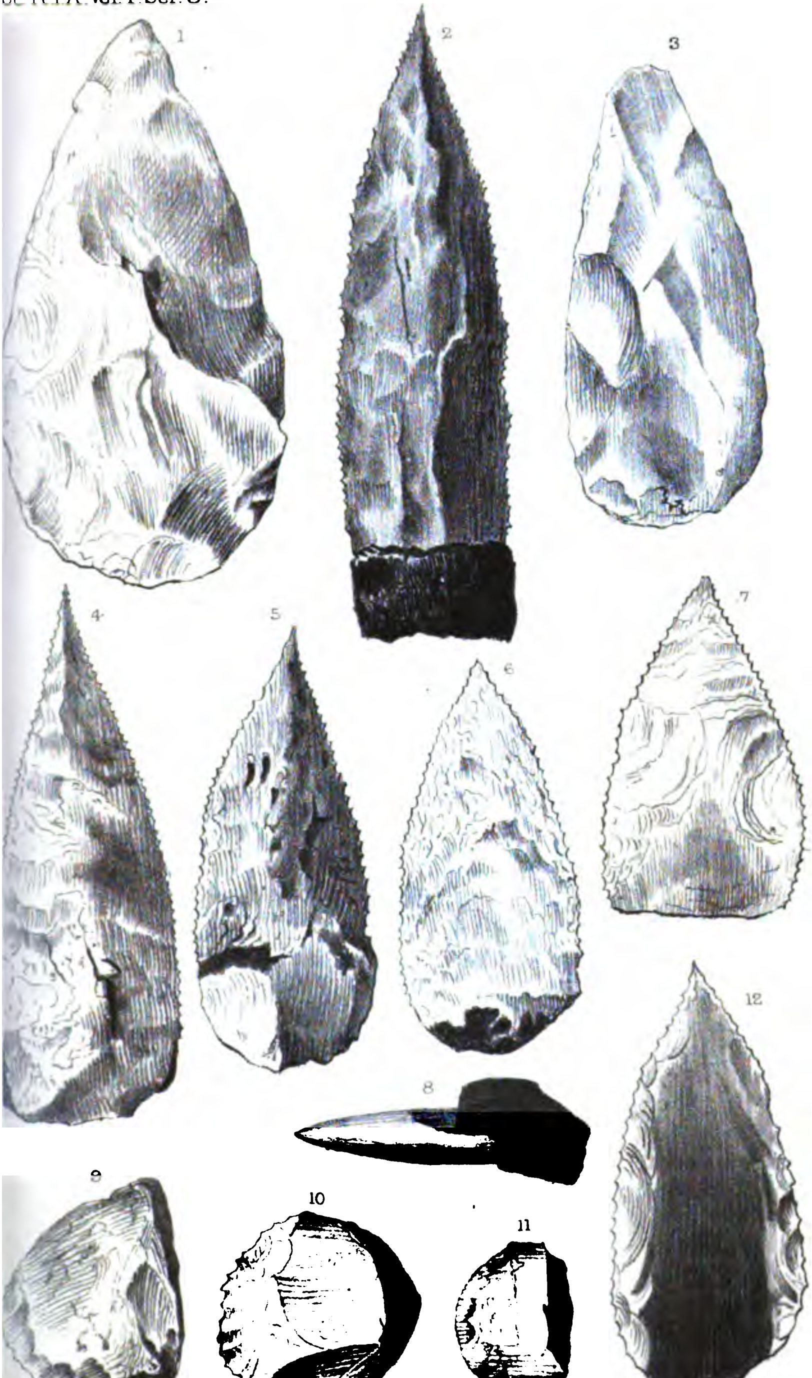
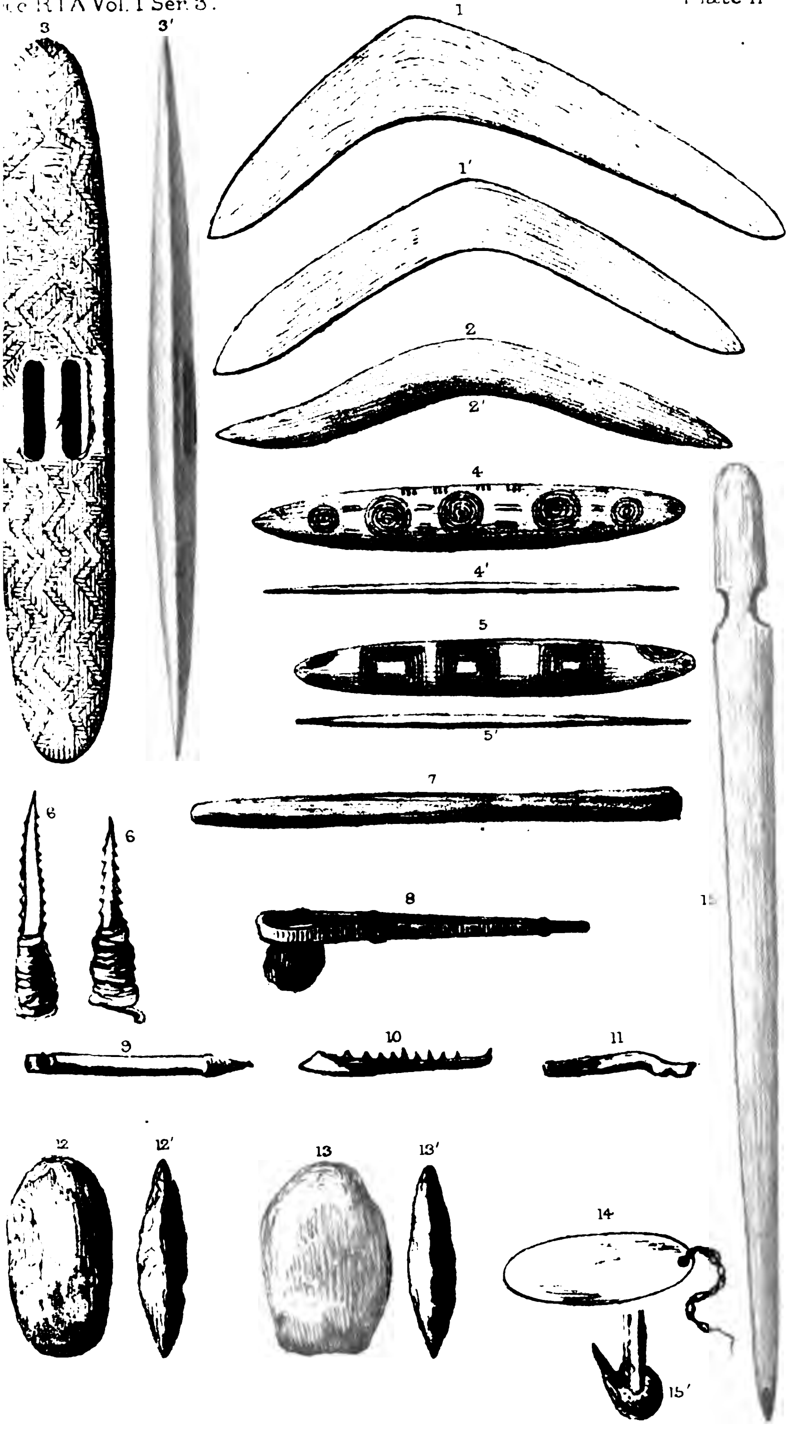


W. F. Wakeman del.
West, Newman & Co lith.

Plate II



A. F. Wakeman del

West, Newman & Co lith

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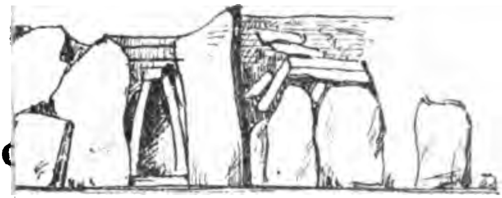
W. F. Wakeman del. West, Newman & Co lith.

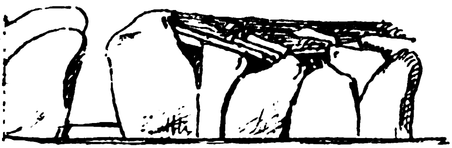
Pro

Plate IX.

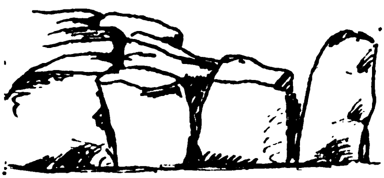
LEVATION T TO U.



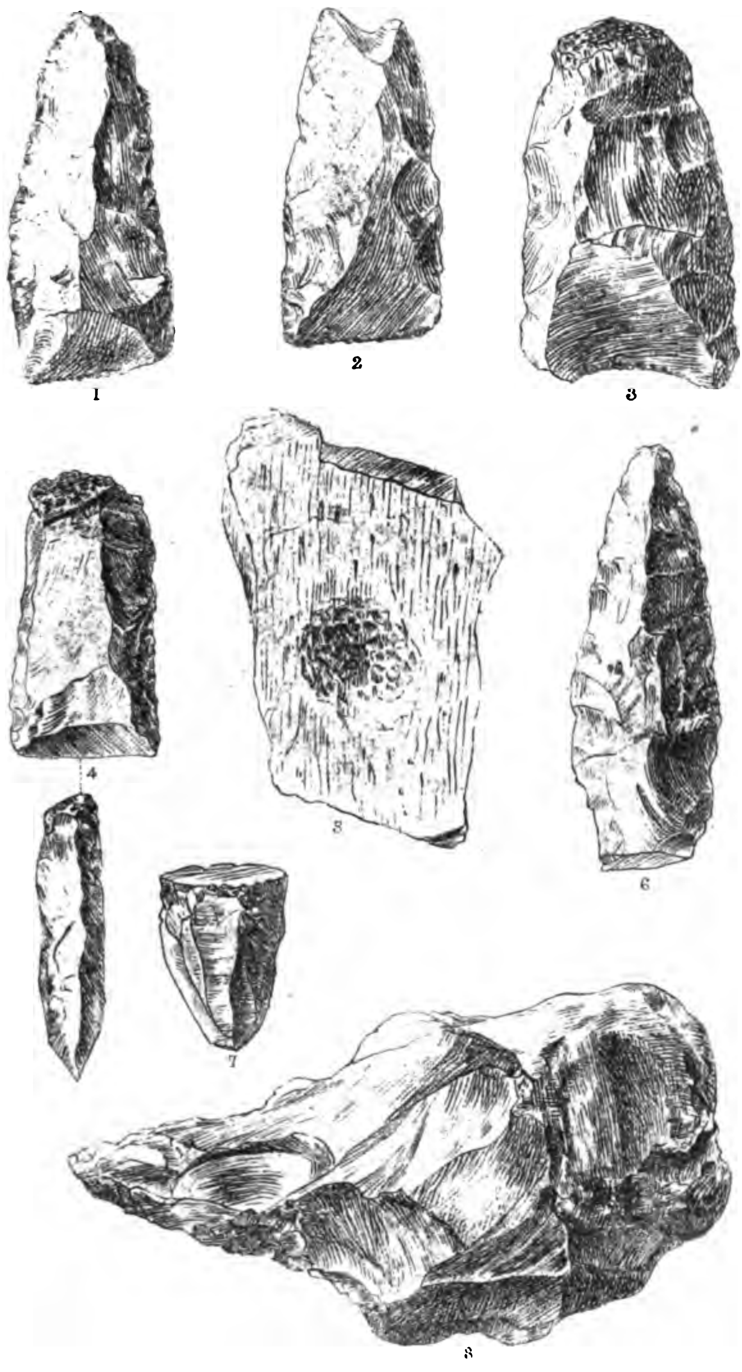
ELEVATION R TO S



ELEVATION V TO W



ELEVATION X TO Y



SCALE, ½ LINEAR MEASURE.

M. Knowles.

Forster & Co.,

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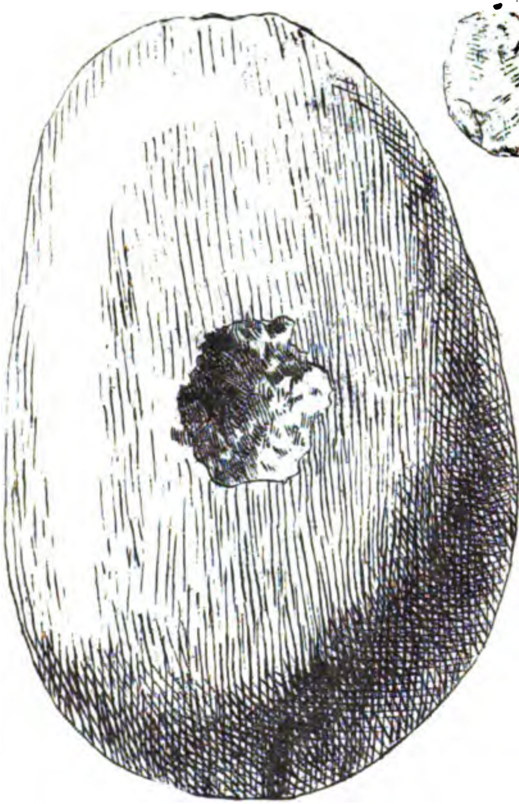

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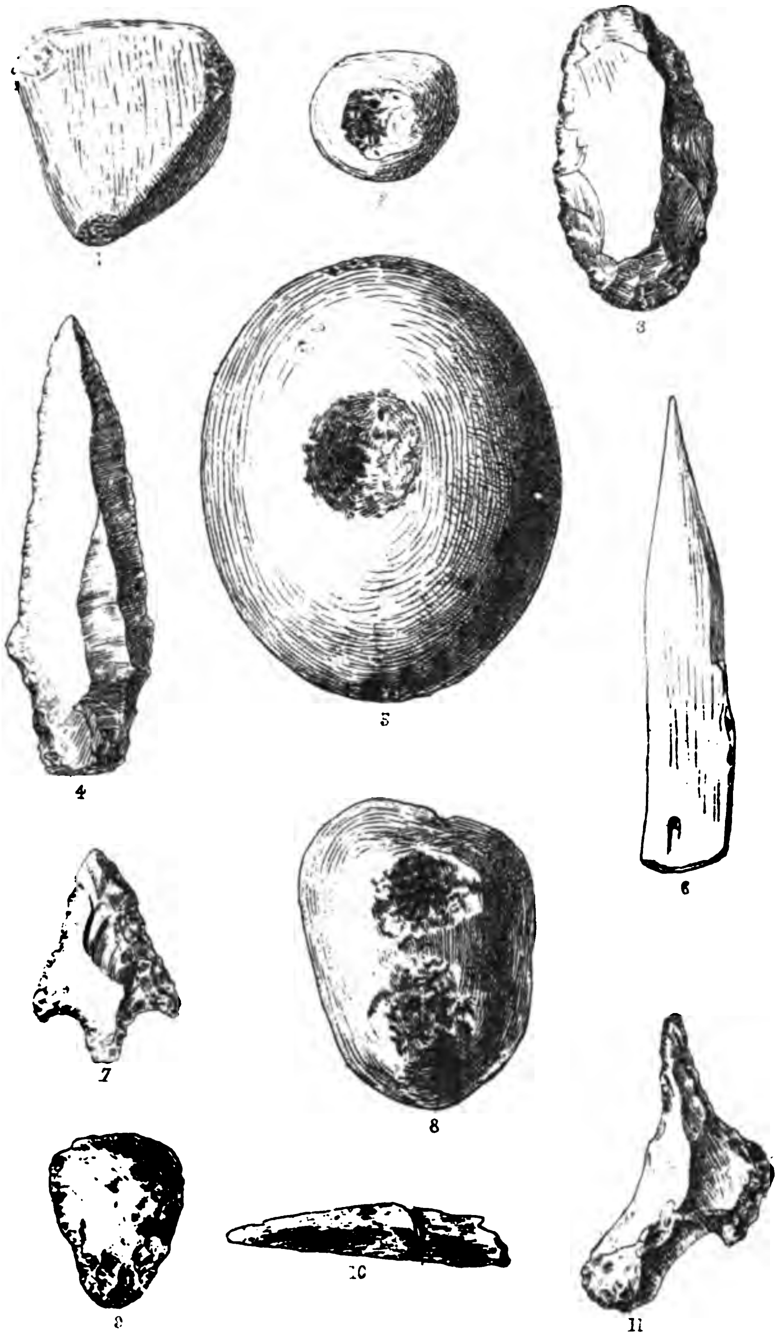
SCALE, ½ LINEAR MEASURE.

M. Knowles.

Forster & Co., I



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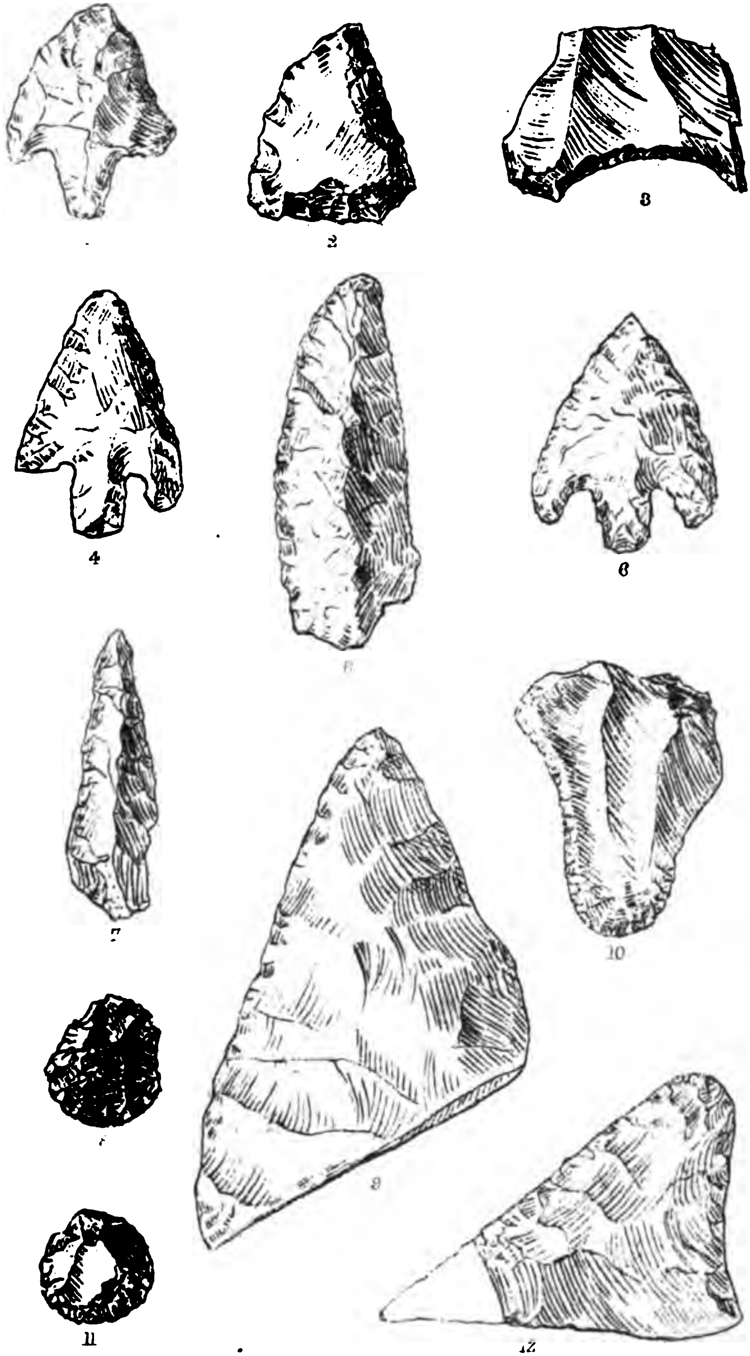
M. Knowles.

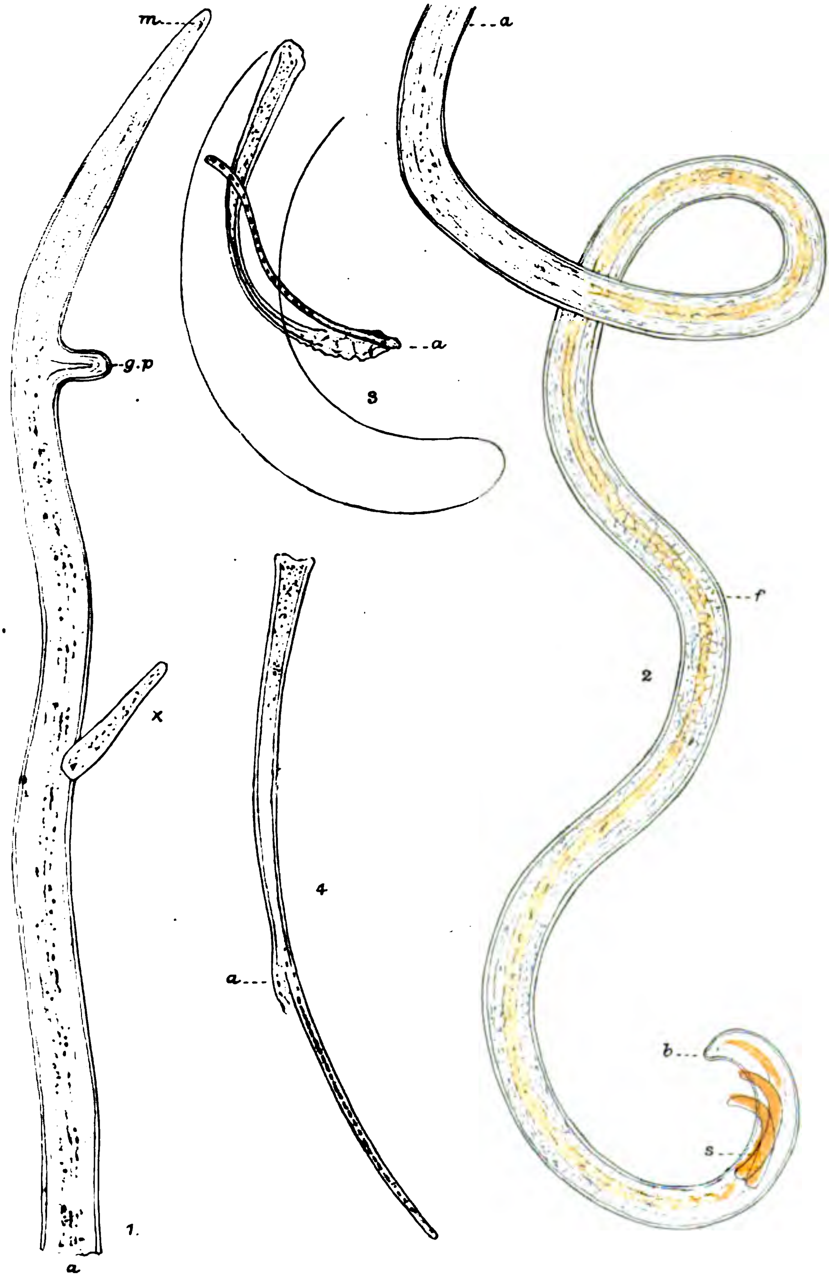
Forster & Co., Photo-Lith.



NATURAL SIZE.

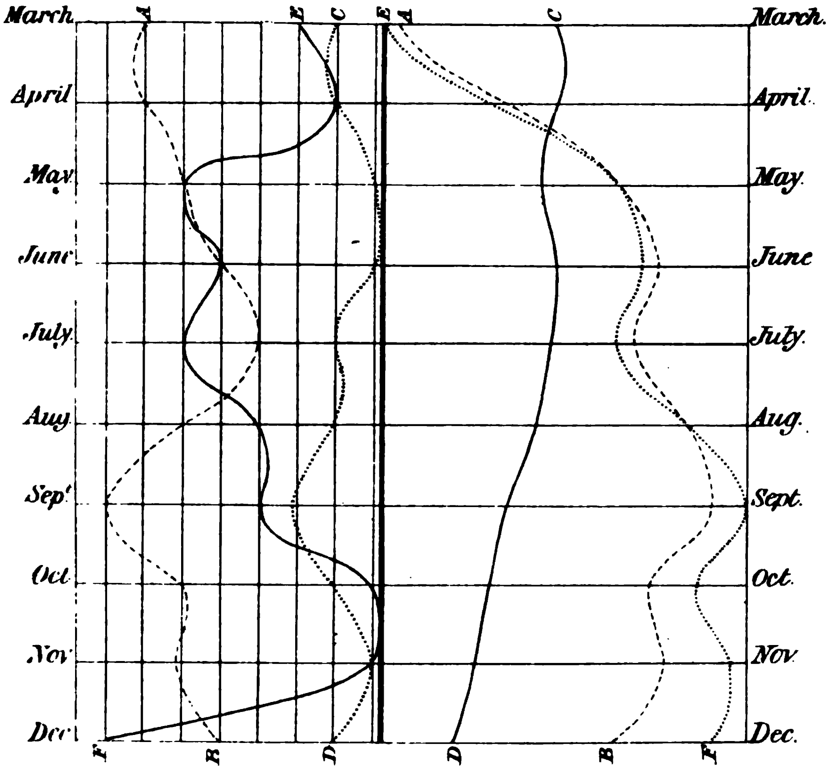
M. KNOWLES

FORSTER & Co., PHOTO-LITH.



West, Newman chr. lith.

DIAGRAM SHOWING VARIATIONS OF MAGNETIC ELEMENTS AT VALENCIA AND KEW.



A.B.	Horizontal Force, Valencia.	A.B.	Declination at Valencia.
C.D.	„ „ Kew.	C.D.	„ „ Kew.
E.F.	Dip. at Valencia.	E.F.	Difference of Declinations.

Forster & Co., Lith., Dublin.

Fig. 1

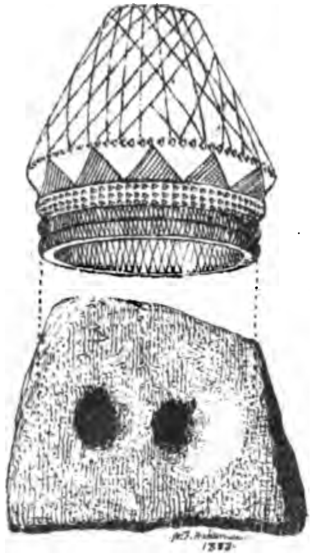
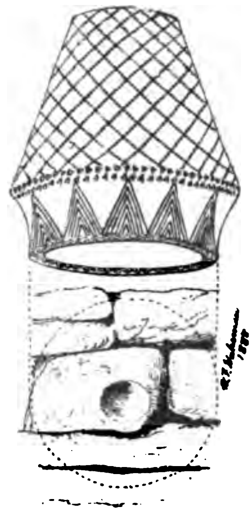


Fig. 2



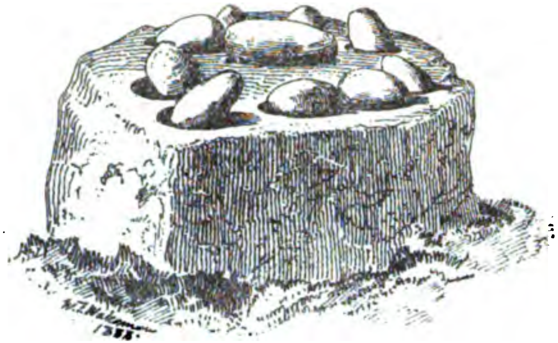
DRUMNAKILLY.

FORSTER & CO, PHOTO-LITH., DUBLIN

Fig. 1

FIVE HOLED BULLÀN, AT KEIM-AN-EIGH.

Fig. 2



TEN HOLED BULLÀN—KILLINAGH.

Fig. 3

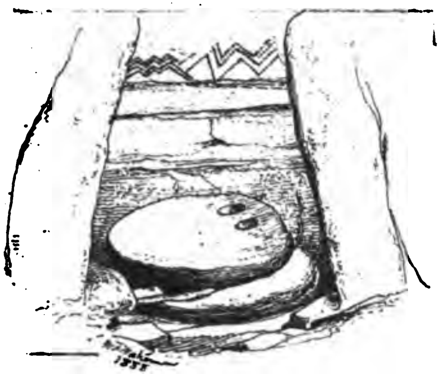
AT KILL-OF-THE-GRANGE, Co. DUBLIN.

Fig. 4

BULLÀN AT CONG, Co. GALWAY.

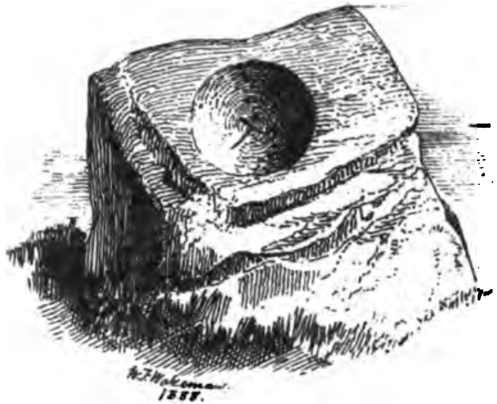
FORSTER & Co. LITH. DUBLIN.

Fig. 1



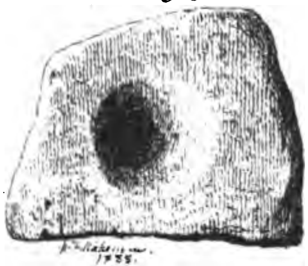
STONE BASIN, EXHIBITING TWO BULLÀNS, IN THE GREAT CARN OF NEW-GRANGE.

Fig. 2



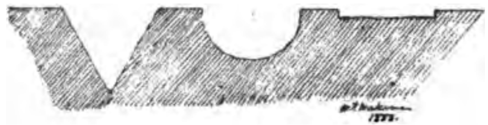
CROSS INSCRIBED BULLÀN, DRUMGAY LAKE, ENNISKILLEN.

Fig. 3



DRUMNAKILLY.

Fig. 4



SECTION OF BULLÀN BASINS, SHOWING VARIOUS FORMS.

FORSTER & CO, PHOTO-LITH., DUBLIN.

Fig. 2.

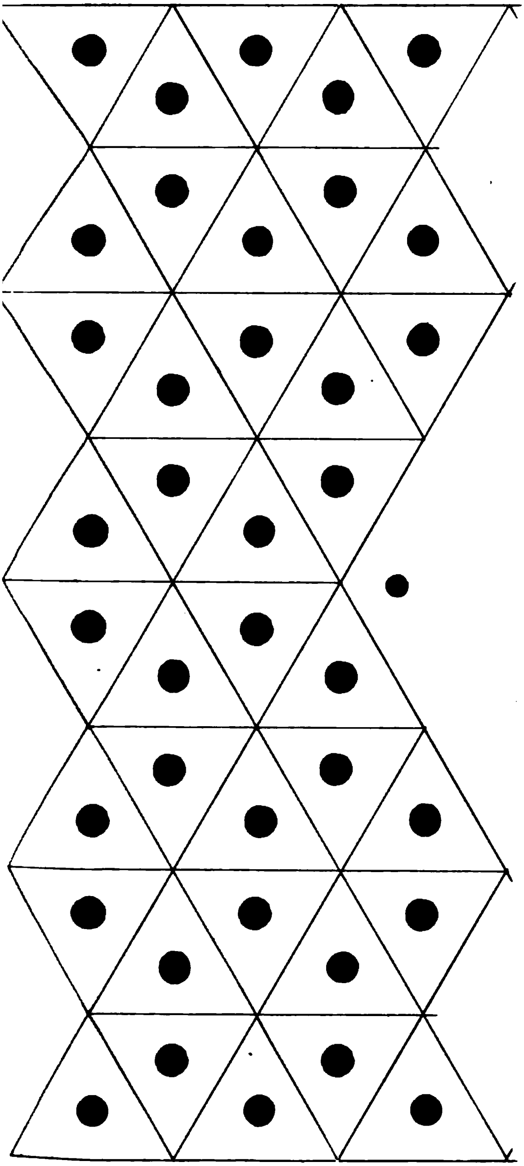
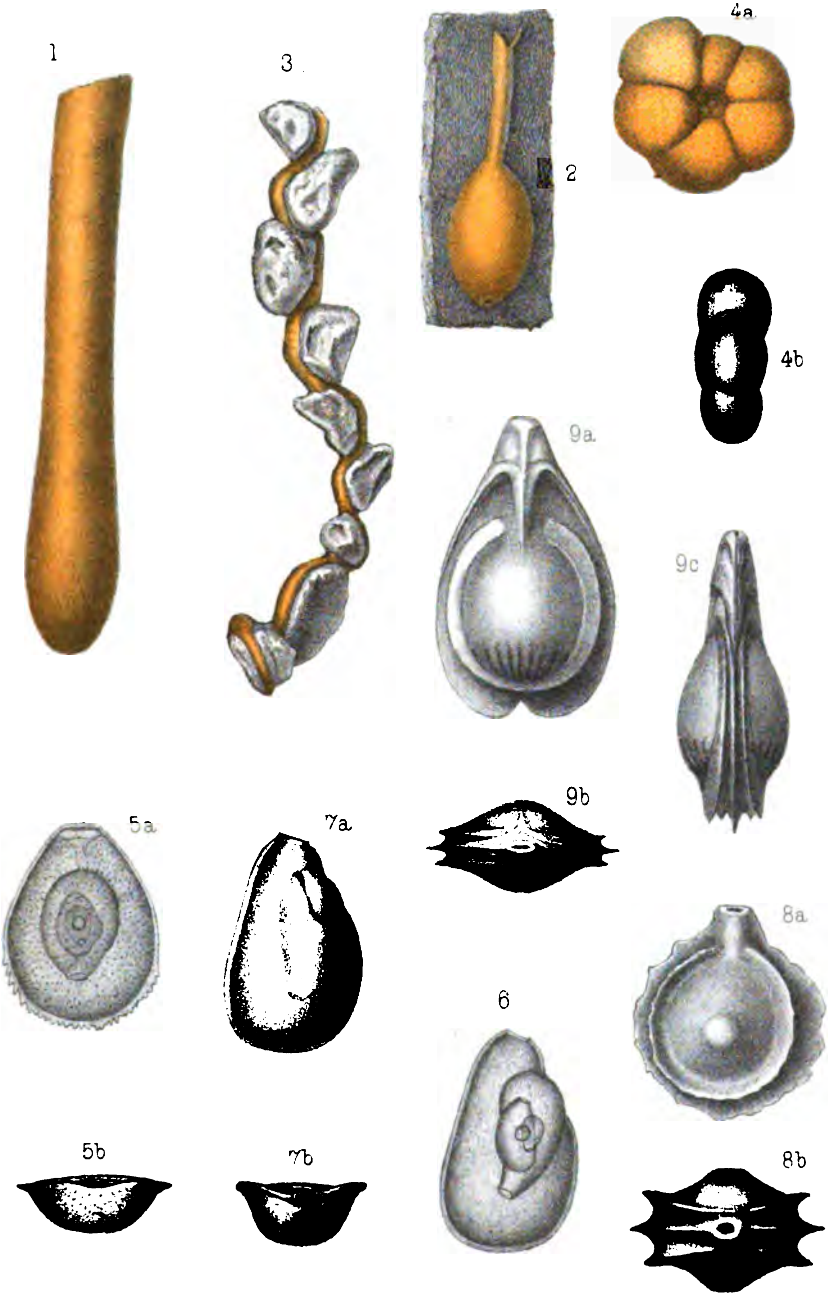
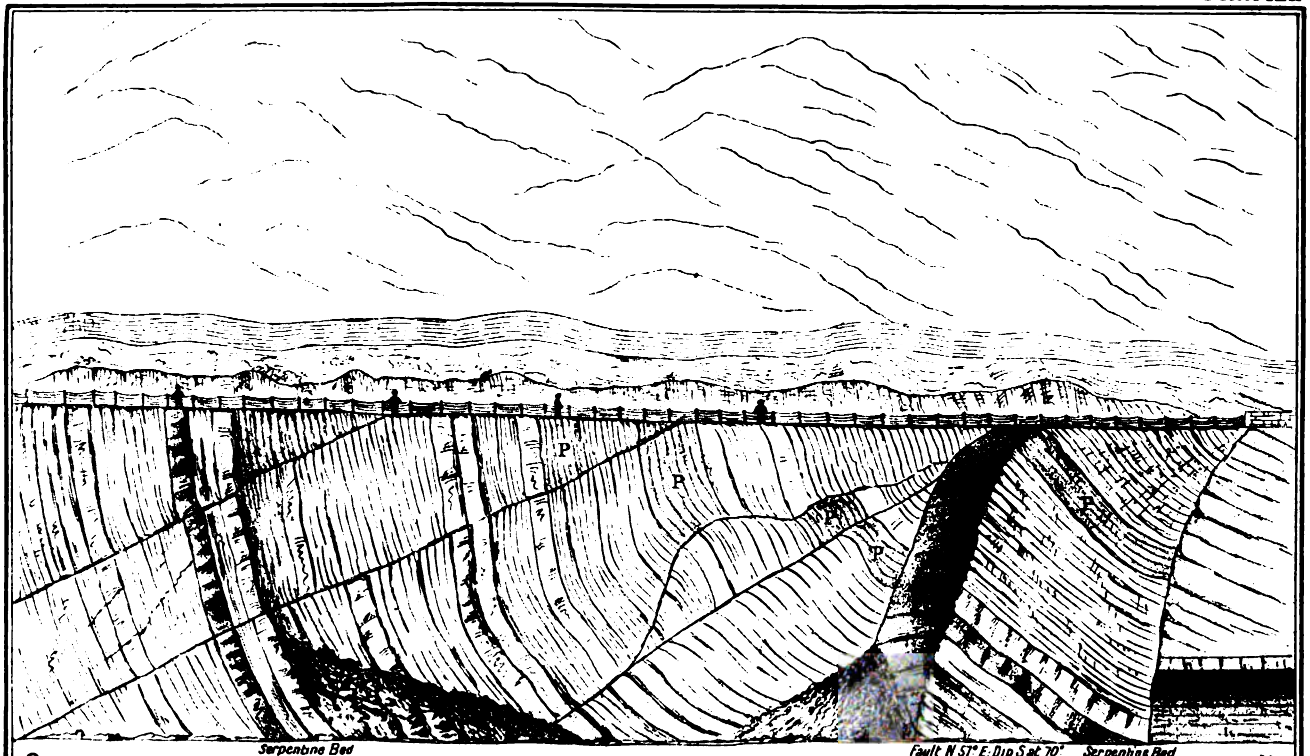


Fig. 1

West, Newman lith.



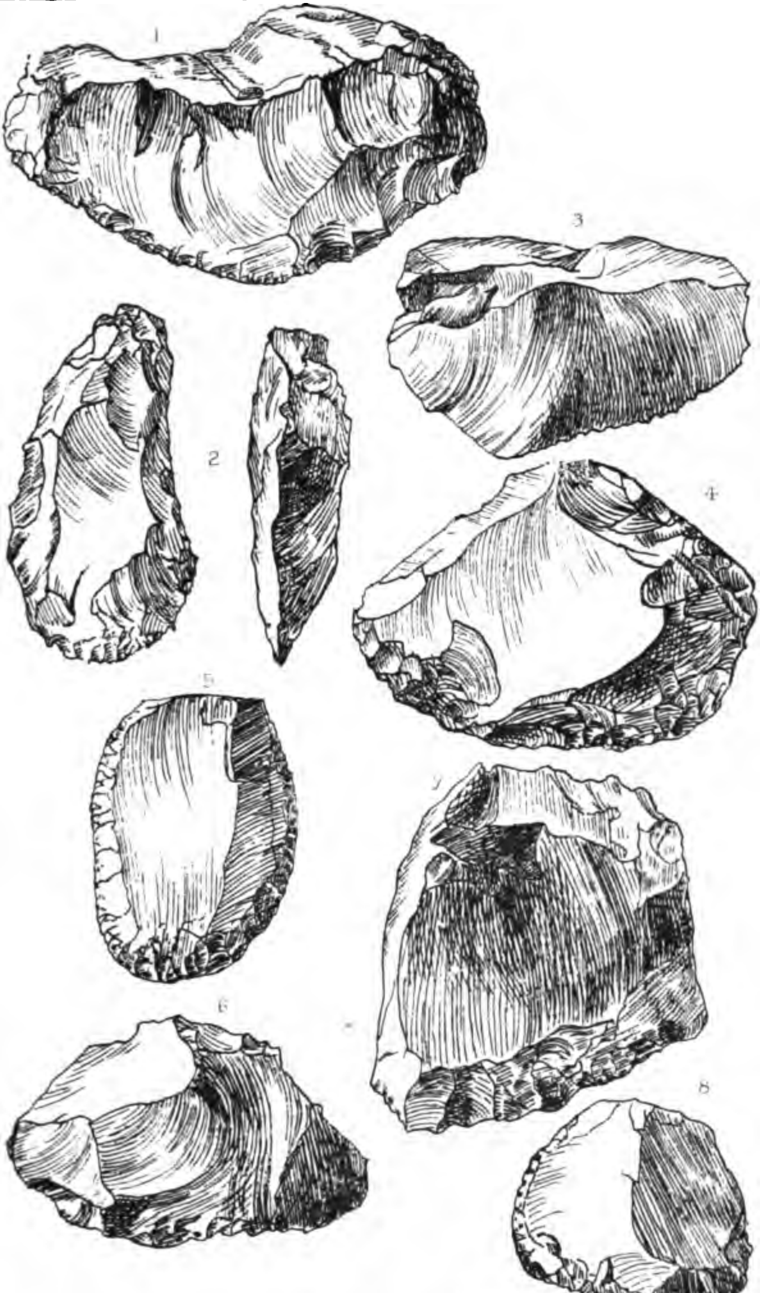
Lith. & Imp. Camb. Sci. Inst. Co.



S. N.

Section S/N on Railway showing relation of Serpentine Bed to adjacent Beds
Scale:- 1 m/m to 1 Yard. P = *purple beds.*

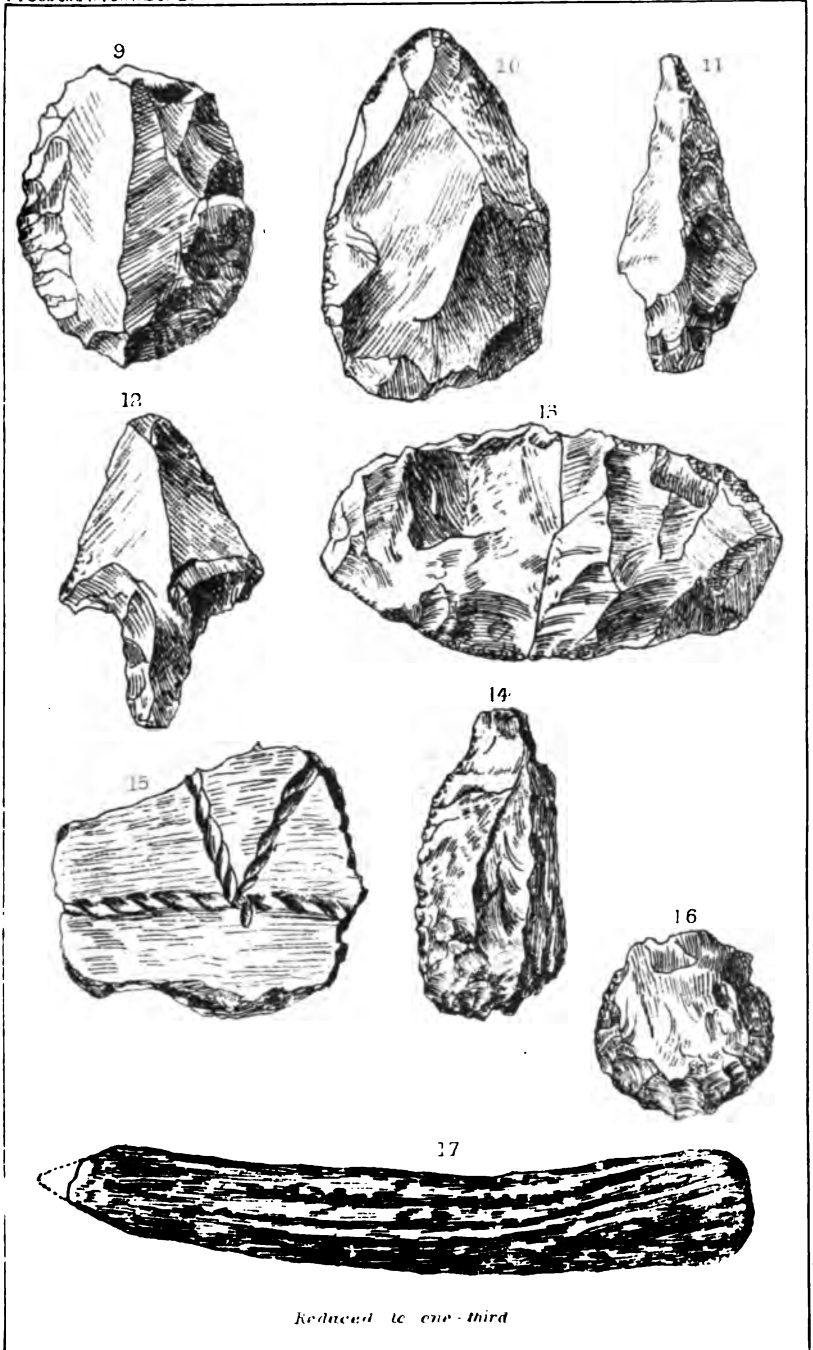
J P O'Reilly del. Geo West & Sons lith et imp



Reduced to one third

M. Knowles

Forster & Co. Photo. Lith.



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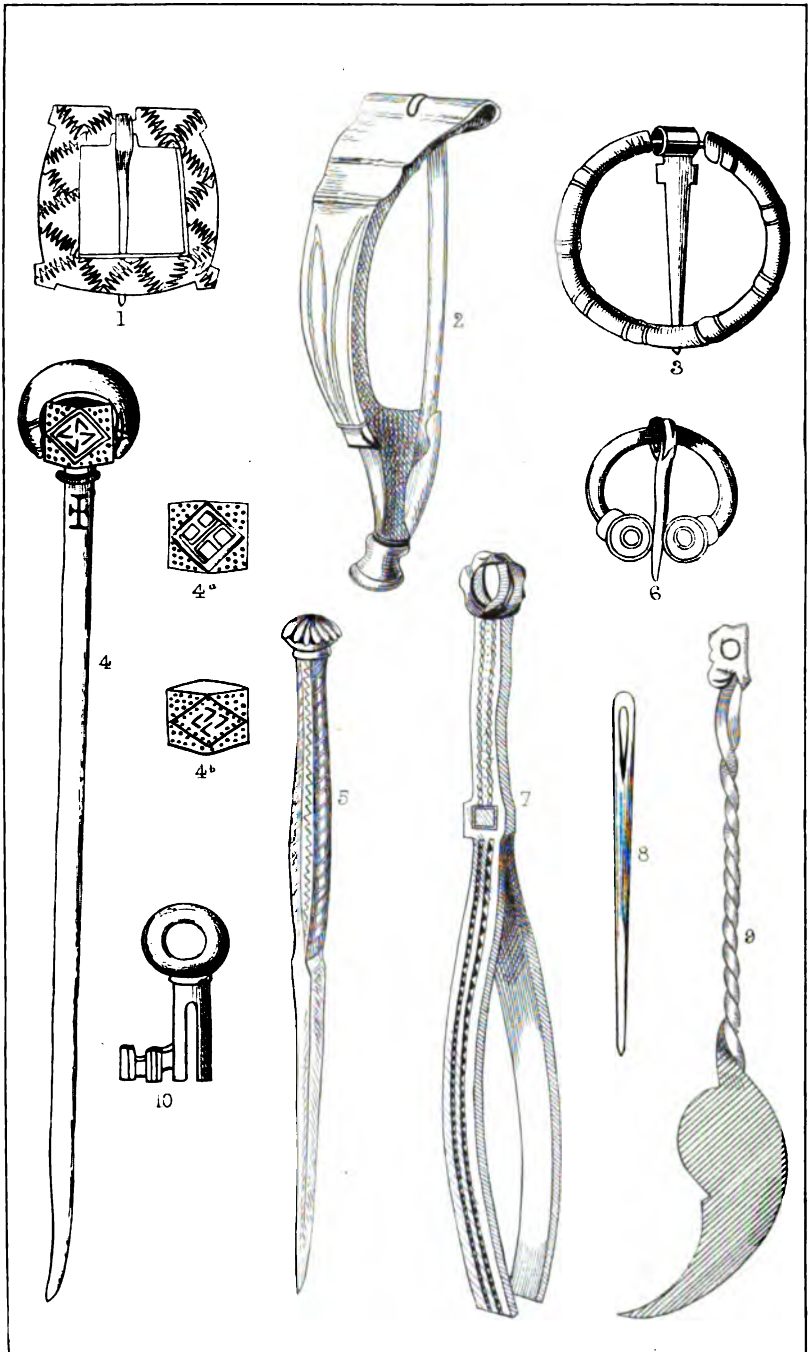
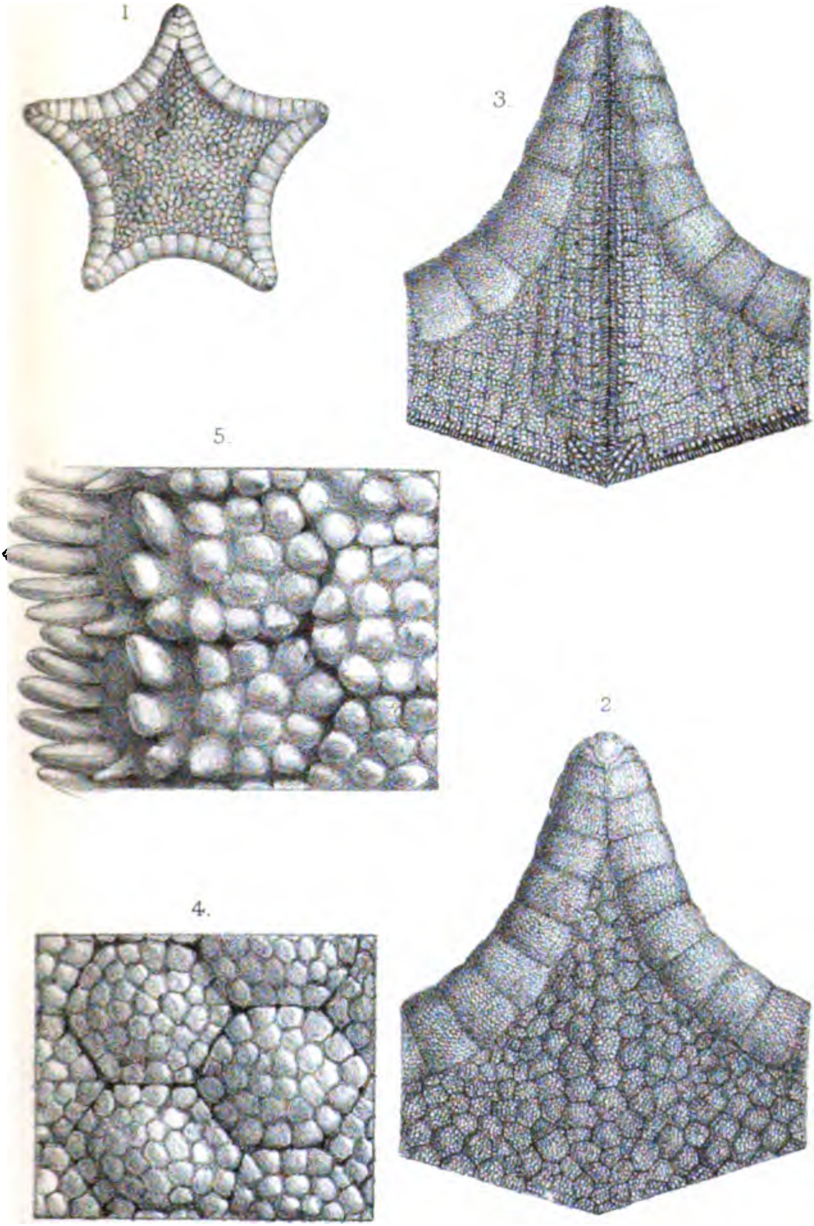
M. Knowles Forster & Co. Photo Lith.



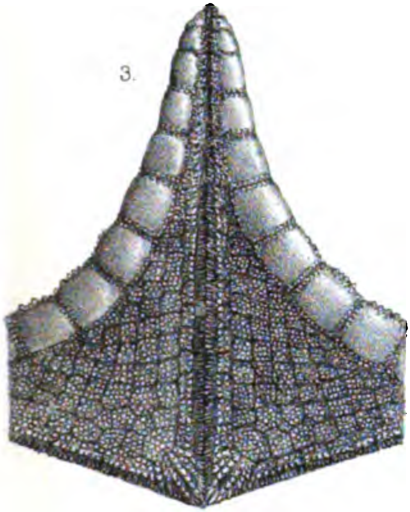
M Knowles Forster & Cº Lith.



F. H. Michael del et lith West, Newman, imp

PENTAGONASTER BALTEATUS, *Sladen.*

3.



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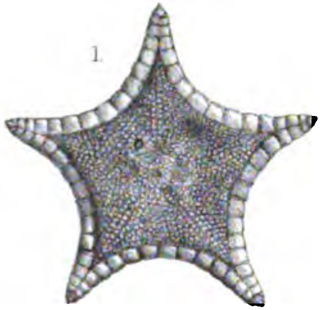

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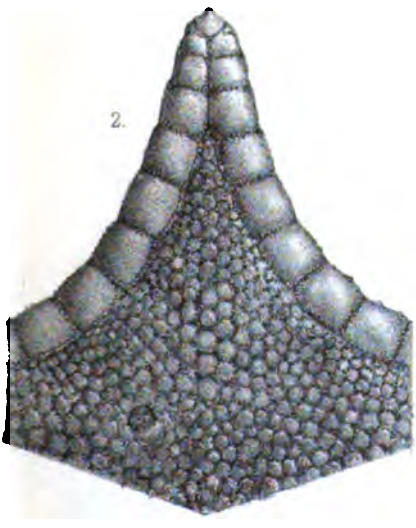

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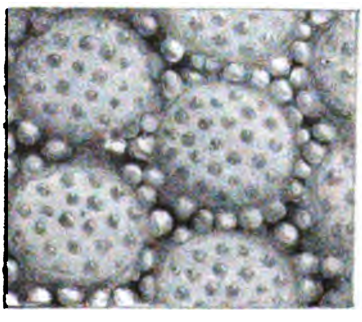
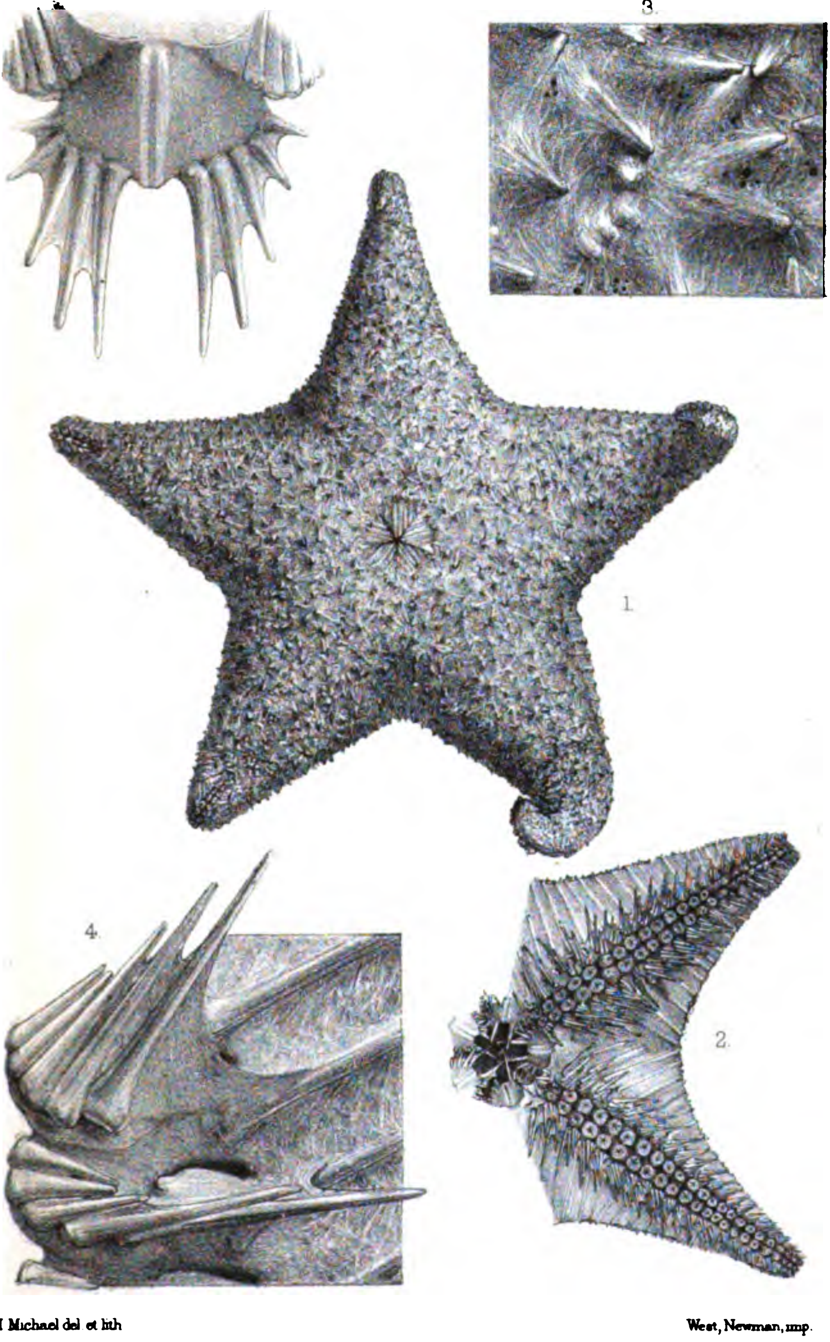


F H Michael del. et lith. West, Newman, imp.

PENTAGONASTER CONCINNUS, *Sladen.*



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PTERASTER PERSONATUS, *Sladen.*

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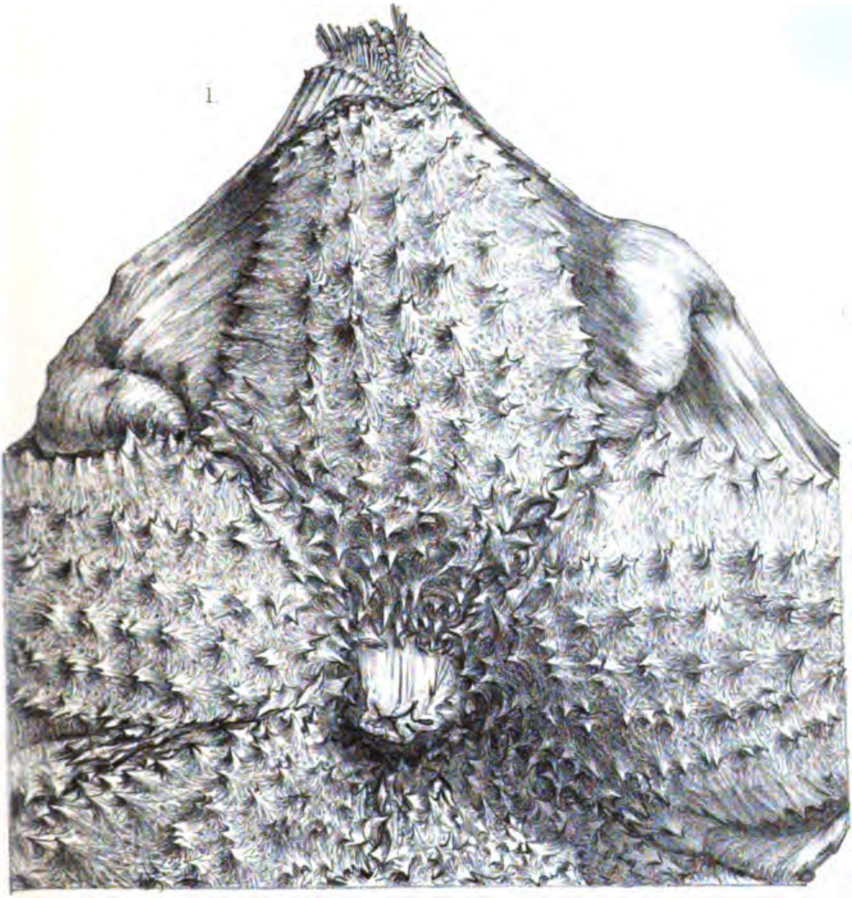

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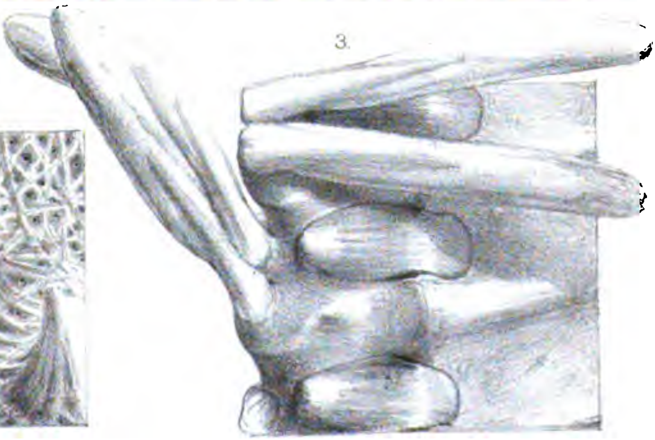
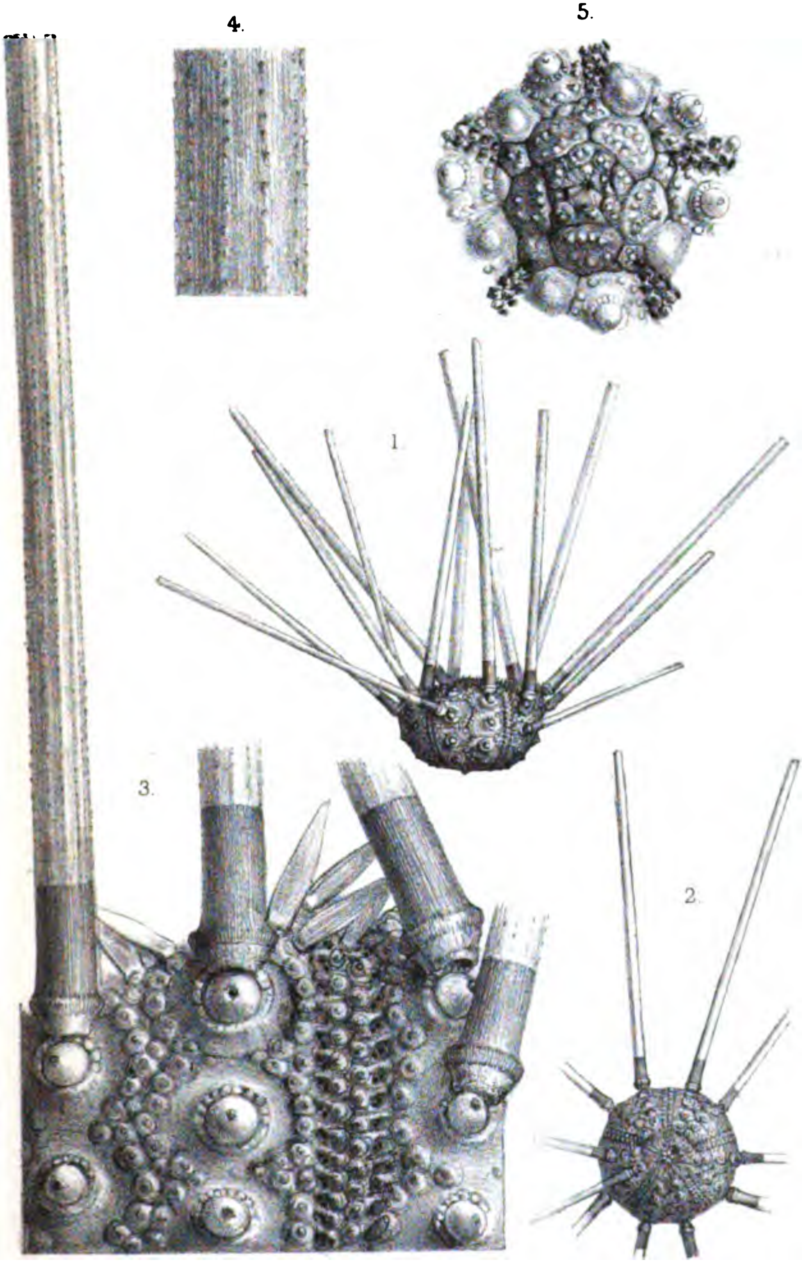


F. H. Michael del. et lith.

West, Newman, imp.

HYMENASTER GIGANTEUS, *Sladen*.



F. H. Michael del et lith.

West, Newman, imp.

POROCIDARIS GRACILIS, *Sladen.*

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(18)	„ 1884	PATRICK W. JOYCE, LL.D.
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(20)	„ 1887	MR. JUSTICE O'HAGAN, M.A.
(21)	„ 1888	JOHN T. GILBERT, F.S.A.

Vice-Presidents:

(*As nominated by the President, 16th of March, 1888: with the dates from which they have continuously been re-appointed.*)

(1) J. P. O'REILLY, C.E. (1886).

(2) RIGHT HON. SIR PATRICK J. KEENAN, C.B., K.C.M.G., (1887).

(3) HON. MR. JUSTICE O'HAGAN, M.A., (1887).

(4) BENJAMIN WILLIAMSON, M.A., F.R.S., (1888).

Officers:

(*Elected annually by the Academy; with date of first election.*)

Treasurer,	REV. MAXWELL H. CLOSE, M.A. (1878).
Secretary,	ED. PERCEVAL WRIGHT, M.A., M.D., (1883).
Secretary of the Council,	ROBERT ATKINSON, LL.D., (1878).
Secretary of Foreign Correspondence,	JOSEPH P. O'REILLY, C.E., (1880).
Librarian,	JOHN T. GILBERT, F.S.A., (1888).
Clerk of the Academy,	ROBERT MACALISTER, LL.B. (1882).

Curator, Museum-Clerk, and House-keeper,	MAJOR ROBT. MacENIRY.
Library Clerk and Serjeant-at-Mace,	MR. J. J. MacSWEENEY.

Committees appointed by Council:

Publication.

Dr. Atkinson.
Sir Robert Ball.
Rev. M. H. Close.
Mr. Gilbert.
Dr. Ingram.
Mr. O'Reilly.
Dr. Tarleton.
Dr. Wright.

Library.

Dr. Atkinson.
Mr. V. Ball.
Rev. M. H. Close.
Dr. Cunningham.
Dr. Frazer.
Mr. Gilbert.
Dr. Joyce.
Mr. O'Reilly.
Dr. Tichborne.
Mr. Williamson.
Dr. Wright.

Irish Manuscripts.

Dr. Atkinson.
Dr. Casey.
Rev. M. H. Close.
Mr. Gilbert.
Dr. Ingram.
Dr. Joyce.
Mr. Justice O'Hagan.
Dr. Sigerson.

Economy and House.

Mr. V. Ball.
Rev. M. H. Close.
Dr. Frazer.
Mr. Garstin.
Sir Patrick Keenan.
Mr. O'Reilly.
Mr. Pigot.
Dr. Sigerson.
Dr. Wright.

MEMBERS OF THE ROYAL IRISH ACADEMY.

ORDINARY MEMBERS.

The sign * is prefixed to the names of Life Members.

The sign § indicates the Members who have contributed papers to the Transactions of the Academy.

N.B.—The names of *Members whose addresses are not known* to the Secretary of the Academy, are printed in italics. He requests that they may be communicated to him.

Date of Election.	
1843. April 10	*§Allman, George James, M.D. (Dub. and Oxon.), LL.D., F.L.S., F.R.C.S.I., F.R.SS., Lond. & Edin., Royal Medalist R.S., 1873. *Ardmore, Parkstone, Dorsetshire; Athenæum Club, London.*
1871. June 12	*Amherst, William Amhurst Tyssen-, D.L., M.P., F.S.A., M.R.S.L. *Didlington Hall, Brandon, Norfolk.*
1873. Jan. 13	Andrews, Arthur. *Newtown House, Blackrock, Co. Dublin.*
1870. Jan. 10	*Archer, William, F.R.S. *National Library, Dublin.*
1870. April 11	Ardilaun, Right Hon. Arthur, Baron, M.A. *Ashford, Cong, Co. Galway; St. Anne's, Clontarf, Co. Dublin.*
1884. May 12	Atkinson, George Mounsey. 28, *St. Oswald's-road, West Brompton, London.*
1875. Jan. 11	Atkinson, Robert, LL.D., Professor of Sanskrit and Comparative Philology, Dublin University, Secretary of Council of the Academy. *Clareville, Upper Rathmines, Co. Dublin.*
1872. April 8	Baily, William Hellier, F.L.S., F.G.S., Geological Survey of Ireland, Demonstrator in Palæontology, Royal College of Science, Dublin. 3 *Church-avenue, Rathmines, Co. Dublin.*
1840. April 13	*Ball, John, M.A., F.R.S., F.L.S. 10, *Southwell Gardens, South Kensington, London, S.W.*
1870. Jan. 10	§Ball, Sir Robert Stawell, LL.D., F.R.S., F.R.A.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. *The Observatory, Dunsink, Co. Dublin.*
1883. June 11	§Ball, V., M.A., F.R.S., Director, Science and Art Museum, Dublin. 28, *Waterloo-road, Dublin.*
1842. Jan. 10	*Banks, John T., M.D., F.K.Q.C.P.I. 45, *Merrion-square, East, Dublin.*
1868. Jan. 13	*Barker, W. Oliver, M.D., M.R.C.S.E. 6, *Gardiner's-row, Dublin.*

Date of Election.	
1874. May 11	Barrett, William F., F.R.S.E., Professor of Physics, Royal College of Science, Dublin. 6, *De Vesci-terrace, Kingstown.*
1884. Feb. 11	*Barrington, Richard Manliffe, M.A., LL.B. *Fassaroe, Bray.*
1886. June 28	*Barry, Rev. Edmond, P.P. *Rathcormac.*
1880. Feb. 9	*Barry, Michael, M.D. 16, *Albion-street, Hyde-park, London, W.*
1880. Feb. 9	*Barter, Rev. John Berkeley, F.R.G.S.I., F.R.H.A.A.I. 21 *Via Assieta, Turin.*
1879. Feb. 10	*Beaney, James G., M.D. *Melbourne, Australia.*
1865. Jan. 9	*Beauchamp, Robert Henry, 25, *Fitzwilliam-square, South, Dublin.*
1863. April 27	*Belmore, Right Hon. Somerset Richard, Earl of, M.A., D.L., K.C.M.G. *Castle Coole, Enniskillen.*
1884. May 12	Bell, Hamilton, F.R.G.S.I. 46 *North Great George's-street, Dublin.*
1866. June 11	Bennett, Edward Hallaran, M.D., M.Ch., F.R.C.S.I., F.R.G.S.I., Professor of Surgery in the University of Dublin. 26, *Lower Fitzwilliam-street, Dublin.*
1887. Jan. 10	Birch, Rev. John George, M.A. *Kilfinaghty Glebe, Bunratty, Co. Clare.*
1854. April 10	**Brady, Cheyne.*
1849. April 9	*Brady, Daniel Fredk., F.R.C.S.I., M.R.C.S.E., J.P. *La Choza, Rathgar-road, Co. Dublin.*
1878. May 13	Browne, John. *Drapersfield, Cookstown, Co. Tyrone.*
1851. Jan. 13	*Browne, Robert Clayton, M.A., D.L. *Browne's Hill, Carlow.*
1886. April 12	Browne, William James, M.A. (Lond.) *Omagh.*
1887. Jan. 10	Burbidge, Frederick William, F.L.S. 91 *Haddington-road, Dublin.*
1874. Feb. 9	Burden, Henry, M.A., M.D., M.R.C.S.E. 8, *Alfred-street, Belfast.*
1854. April 10	Burke, Sir John Bernard (Ulster), LL.D., C.B. *Tullamaine House, Upper Leeson-street, Dublin.*
1888. April 9	Burtchaell, George Dames, M.A., LL.B. 51 *More-hampton-road, Dublin.*
1855. Jan. 8	*Butcher, Richard G., M.D., F.R.C.S.I., M.R.C.S.E. 19, *Lower Fitzwilliam-street, Dublin.*
1876. May 8	Byrne, William H., C.E. 2 *Mountjoy-square, Dublin.*
1873. May 12	Carlingford, Right Hon. Chichester, Baron, K.P., Lieutenant of Essex. *Ravensdale Park, Dundalk, Co. Louth.*
1887. Jan. 10	Carroll, Thomas. *The Albert Institution, Glasnevin.*
1838. Feb. 12	*Carson, Rev. Joseph, D.D., S.F.T.C.D., F.R.G.S.I. 18, *Fitzwilliam-place, Dublin.*

Date of Election.	
1876. Jan. 10	Carton, Richard Paul, Q.C. 35, *Rutland-square, West, Dublin.*
1883. June 11	Cartwright, Sir Henry Edmund, LL.B., J.P. 1 *Courtfield Gardens, London, S.W.*
1866. May 14	§Casey, John, LL.D., F.R.S., Professor of Higher Mathematics and Mathematical Physics, Catholic University. 86, *South Circular-road, Dublin.*
1878. May 13	*Cathcart, George L., M.A., F.T.C.D. 106, *Lower Baggot-street, Dublin.*
1842. June 13	*Chapman, Sir Benjamin James, Bart., Lieutenant of the County Westmeath. *Killua Castle, Clonmellon.*
1864. Jan. 11	Charlemont, Right Hon. James Molyneux, Earl of, K.P., Lieutenant of the County Tyrone. *Roxborough Castle, Moy, Co. Tyrone.*
1876. April 10	*Clarke, Rev. Francis E., M.A., M.D., LL.D., L.K.Q.C.P.I., M.R.C.S.E. *The Rectory, Boyle, Co. Roscommon.*
1867. May 13	*Close, Rev. Maxwell H., M.A., F.R.G.S.I., F.G.S., Treasurer of the Academy. 40, *Lower Baggot-street, Dublin.*
1885. Dec. 14	*Cochrane, Robert, C.E. 2 *Clapham-villas, Terenure-road, Co. Dublin.*
1886. Feb. 8	Coffey, George, B.A., B.E. 5 *Harcourt-terrace, Dublin.*
1882. Feb. 13	*Collins, Charles MacCarthy. *Union Bank of Australia, Brisbane.*
1882. June 26	*Collum, Rev. Hugh Robert, F.S.S. *Leigh Vicarage, Tonbridge, Kent.*
1885. Feb. 9	Colthurst, James, M.A., LL.D., 55 *Grand Parade, Cork.*
1882. Feb. 13	Comerford, Very Rev. Michael, P.P. *Monasterevan, Co. Kildare.*
1885. June 8	Conlan, Rev. Robert. *Parochial House, Marlborough-street.*
1866. April 9	Cooper, Lieut. Col. Edward H., Lieutenant of the County Sligo. *Markree Castle, Collooney.*
1878. June 24	Corbet, William J., M.P. *Springfarm, Delgany.*
1864. May 9	*Cotton, Charles Philip, B.A., C.E., F.R.G.S.I., *Ryecroft, Bray.*
1876. Apr. 10	Cox, Michael Francis, B.A., L.R.C.S.I. 45, *Stephen's-green, East, Dublin.*
1882. Feb. 13	*Cox, William Sidney, C.E. 66, *George-street, Limerick.*
1884. May 12	Cranny, John Joseph, B.A., M.D., F.R.C.S.I. 17 *Merrion-square, North, Dublin.*
1886. Jan. 11	Crawford, Robert, M.A., M.E. *Trinity College, Dublin.*

Date of Election.	
1866. June 11	*Cruise, Francis R., M.D., F.K.Q.C.P.I., M.R.C.S.E. 93, *Merrion-square, West, Dublin.*
1870. Apr. 11	Cruise, Richard Joseph, F.R.G.S.I., Geological Survey of Ireland. 14, *Hume-street, Dublin.*
1885. Dec. 14	*§Cunningham, Daniel J., M.D., Professor of Anatomy, University of Dublin. 69, *Harcourt-street, Dublin.*
1876. Nov. 13	*Dalway, Marriott R., D.L. *Bella Hill, Carrickfergus.*
1886 June 28	Dames, Robert Staples Longworth, B.A. (Dub.) 21, *Herbert-street, Dublin.*
1853. April 11	*Davies, Francis Robert, K.J.J. *Hawthorn, Carysfort-avenue, Blackrock, Co. Dublin.*
1855. May 14	*§Davy, Edmund W., M.A., M.D., Prof. of Med. Jurisprudence, Royal College of Surgeons, Ireland. 1, *Fortfield Terrace, Templeogue, Co. Dublin.*
1846. April 13	*D'Arcy, Matthew P., M.A., D.L. 40, *Merrion-square, East, Dublin.*
1876. Jan. 10	Day, Robert, Jun., F.S.A. *Sidney-place, Cork.*
1876. Jan. 10	Deane, Thomas Newenham, R.H.A., F.R.I.A.I. 3, *Upper Merrion-street, Dublin.*
1884. Feb. 11	*Delany, Very Rev. William, S.J., LL.D. *Upper Gardiner-street, Dublin.*
1860. Jan. 9	*Dickson, Rev. Benjamin, D.D. 3, *Kildare-place, Dublin.*
1876. Feb. 14	Dillon, William. *Sedalia, Douglas County, Colorado, U.S.A.*
1876. Jan. 10	*§Doberck, William, Ph.D. *The Observatory, Hong Kong.*
1851. Jan. 13	*Dobbin, Rev. Orlando T., B.D., LL.D. *St. George's-terrace, Gravesend, Kent.*
1879. June 9	*Doherty, William J., C.E., J.P. *Clonturk House, Drumcondra, Co. Dublin.*
1885. April 13	Donnelly, Most Rev. Nicholas, D.D., Bishop of Canea. 50, *Rathgar-road, Co. Dublin.*
1876. June 26	§Draper, Harry N., J.P., F.C.S. *Esterel, Temple-road, Upper Rathmines, Co. Dublin.*
1843. Jan. 9	*Drury, William Vallancey, M.D. *Bournemouth.*
1861. Feb. 11	Duncan, James Foulis, M.D., F.K.Q.C.P.I. 8, *Upper Merrion-street, Dublin.*
1888. June 25	Earl, Edward H. 40 *Westland-row, Dublin.*
1867. Feb. 11	Ellis, George, M.B., F.R.C.S.I. 91, *Lower Leeson-street, Dublin.*
1841. April 12	*Emly, Right Hon. William, Baron, Lieutenant of the County Limerick. *Tervoe, Limerick; Athenæum Club, London, S.W.*
1867. April 8	*Farrell, Thomas A., M.A. 37 *Merrion-square, East.*

Date of Election.	
1842. Jan. 10	*Ferrier, Alexander. *Knockmaroon Lodge, Chapelizod, Co. Dublin.*
1878. Feb. 11	FitzGerald, George F., M.A., F.T.C.D., F.R.S. 40, *Trinity College, Dublin.*
1875. Jan. 11	FitzPatrick, William John, LL.D., F.S.A., J.P. 49, *Fitzwilliam-square, West, Dublin.*
1887. Jan. 10	*FitzPatrick, Louis, M.R.C.S., L.R.C.S. Ed., J.P. *Queenheyan, New South Wales.*
1881. Jan. 10	Fletcher, Joseph, F.C.SS., London and Berlin. *Sandymount Castle, Co. Dublin.*
1874. Feb. 9	Foster, Rev. Nicholas, M.A. 3 *Albert-ville, Crumlin-road, Belfast.*
1876. Feb. 14	Fottrell, George. 8, *North Great George's-street, Dublin.*
1883. Nov. 12	Frazer, Robert Watson, LL.B., Assoc. R.C.Sc.I. *London Institution, Finsbury Circus, London.*
1866. May 14	*Frazer, William, F.R.C.S.I., F.R.G.S.I. 20, *Harcourt-street, Dublin.*
1865. April 10	Freeland, John, M.D. *Antigua, West Indies.*
1881. June 13	Freeman, D. J., M.R.I.A.I. *Municipal Buildings, Cork-hill, Dublin.*
1847. May 10	*Freke, Henry, M.D. (Dub.), F.K.Q.C.P.I. 12, *Warrington-place, Dublin.*
1873. April 14	*Frost, James, J.P. *Ballymorris, Cratloe, Co. Clare.*
1875. June 14	Furlong, Nicholas, M.D. *Lymington, Enniscorthy.*
1859. Jan. 10	Gages, Alphonse, Chev. L.H., F.R.G.S.I. *Royal College of Science, Dublin.*
1845. April 14	*Galbraith, Rev. Joseph Allen, M.A., S.F.T.C.D., F.R.G.S.I. 8, *Trinity College; 46, Lansdowne-road, Dublin.*
1878. May 13	Galloway, Robert, F.C.S. 60, *Pembridge Villas, Bayswater, London, W.*
1880. June 28	Gannon, John Patrick. *Stephen's-green Club, Dublin.*
1863. Feb. 9	*Garstin, John Ribton, M.A., LL.B., F.S.A., F.R. Hist. Soc., Hon. F.R.I.A.I., D.L. *Braganstown, Castlebellingham, Co. Louth.*
1855. April 9	*Gilbert, John Thomas, F.S.A., R.H.A., Librarian of the Academy. *Villa Nova, Blackrock, Co. Dublin.*
1876. May 8	Gillespie, William. *Racefield House, Kingstown, Co. Dublin.*
1885. June 22	Goodman, Rev. James, M.A., Professor of Irish, University of Dublin. *Trinity College, Dublin.*
1875. April 12	*Gore, J. E., C.E., A.I.C.E., F.R.A.S., F.R.G.S.I., *Beltra, Ballysodare, Co. Sligo.*

Date of Election.	
1836. May 25	*Gough, Right Hon. George S., Viscount, M.A., D.L., F.L.S., F.G.S. *St. Helen's, Booterstown, Co. Dublin*
1848. June 12	*Graham, Andrew, M.A. *Observatory, Cambridge.*
1876. April 10	Grainger, Rev. John (Canon), D.D. *Broughshane, Co. Antrim.*
1863. April 13	Granard, Right Hon. George Arthur Hastings, Earl of, K.P. *Castle Forbes, Co. Longford.*
1837. April 24	*§Graves, Right Rev. Charles, D.D., F.R.S., Lord Bishop of Limerick. *The Palace, Henry-street, Limerick.*
1887. June 27	Gray, Richard Armstrong, C.E., M.I.C.E.I. *Fortfield House, Upper Rathmines.*
1874. Feb. 9	Gray, William. 8, *Mount-Charles, Belfast.*
1867. April 8	Green, James Sullivan, Q.C. 83, *Lower Leeson-street, Dublin.*
1887. May 9	Green, James C.S., M.B. *The Barracks, Fermoy.*
1882. Dec. 11	Greer, Thomas, J.P., F.R.G.S.I. *Sea Park, Carrickfergus; Grove House, Regent's-park, London, N.W.*
1873. Dec. 8	*Guinness, Sir Edward Cecil, Bart., M.A., D.L. 80, *Stephen's green, South, Dublin.*
1887. Jan. 10	§Gwynn, Rev. John, D.D., Regius Professor of Divinity, University of Dublin. *Thorndale, Temple-road, Upper Rathmines.*
1884. Jan. 14	Haddon, Alfred Cort, M.A., F.Z.S., Professor of Zoology in the Royal College of Science for Ireland. 4, *Willow-bank, Kingstown.*
1875. Jan. 11	Hamilton, Edward, M.D., F.R.C.S.I. 120, *Stephen's-green, West, Dublin.*
1879. Dec. 8	Hamilton, Edwin, M.A. 26, *Stephen's-green, North.*
1837. Feb. 13	*§Hart, Sir Andrew Searle, LL.D., Vice-Provost of Trinity College, Dublin. 14, *Lower Pembroke-street, Dublin.*
1886. May 10	Hassé, Rev. Leonard G. *Gracehill, Ballymena.*
1861. May 13	*Hatchell, John, M.A., J.P., D.L. *Fortfield House, Terenure, County Dublin.*
1845. Feb. 24	*§Haughton, Rev. Samuel, M.A., M.D., D.C.L. (Oxon.), LL.D. (Cantab. and Edin.), F.R.S., F.G.S., F.R.G.S.I., F.K.Q.C.P.I., Honorary F.R.C.S.I., S.F.T.C.D., President of the Academy. 12 *North-brook-road, Dublin.*
1852. April 12	*Head, Henry H., M.D., F.K.Q.C.P.I., F.R.C.S.I., F.R.G.S.I. 7, *Fitzwilliam-square, East, Dublin.*

Date of Election.	
1888. Feb. 13	Healy, Most Rev. John, DD., LL.D., Coadjutor Bishop of Clonfert. *Palmerston House, Portumna, Co. Galway.*
1851. Jan. 13	*§Hennessy, Henry, F.R.S., Professor of Applied Mathematics and Mechanics in the Royal College of Science for Ireland. *Brookvale House, Donnybrook, Co. Dublin.*
1865. Feb. 13	*Hennessy, William Maunsell. 71, *Pembroke-road, Dublin.*
1885. April 13	Heron, Robert Finlay, B.A., F.R.G.S.I. *Dawson Court, Blackrock, Co. Dublin.*
1873. Jan. 13	Hickie, James Francis, Lieut.-Col., J.P. *Slevoir, Roscrea, Co. Tipperary.*
1875. Jan. 11	*Hill, Arthur, B.E., A.R.I.B.A. 22, *George's-street, Cork.*
1867. Feb. 11	Hill, John, C.E., F.R.G.S.I. *County Surveyor's Office, Ennis.*
1888. Feb. 13	Hill, Richard Cotton Walker. 7 *Grantham-street, Dublin.*
1881. May 9	Hillis, John David, M.D., F.R.C.S.I. *Demerara, West Indies.*
1882. June 26	Houston, Fred. H., F.R.G.S.I. 6, *Carlisle-terrace, Belfast.*
1866. June 11	Hutton, Thomas Maxwell, J.P., D.L. 118 *Summerhill, Dublin.*
1847. Jan. 11	*Ingram, John Kells, LL.D., S.F.T.C.D. 38, *Upper Mount-street, Dublin.*
1879. April 14	Ingram, Thomas Dunbar, LL.D. 13, *Wellington-road, Dublin.*
1867. April 8	Jephson, Robert H. 18, *Lansdowne-road, Dublin.*
1886. June 28	Johnson, Hugh H., B.A. (Oxon.) *Trinity College, Dublin.*
1863. Jan. 12	*Joyce, Patrick Weston, LL.D. *Lyre na Grena, Leinster-road, Rathmines, Co. Dublin.*
1878. May 13	*Kane, John F. *Leeson-park House, Dublin.*
1831. Nov. 30	*§Kane, Sir Robert, M.D., LL.D., F.K.Q.C.P.I., F.R.S., F.R.G.S.I., F.C.S., Royal Medalist R.S., 1841. *Fortlands, Killiney, Co. Dublin.*
1873. Dec. 8	*Kane, Robert Romney, M.A. *Dungiven, Ailesbury-road, Dublin.*

Date of Election.	
1865. April 10	Kane, William Fran.is De Vismes, M.A., J.P. *Sloperton Lodge, Kingstown.*
1870. June 13	*Keane, John P., C.E., Engineer, Public Works Department, Bengal. *Calcutta.*
1864. Nov. 14	*Keenan, Right Hon. Sir Patrick J., C.B., K.C.M.G., Resident Commissioner, Board of National Education, Ireland. *Delville, Glasnevin, Co. Dublin.*
1870. May 23	*Kelly, John, L.M. (Dub.). *University College Hospital, Calcutta.*
1846. April 13	*Kennedy, James Birch, J.P. *Cara, by Killarney.*
1866. April 9	*Kinahan, Sir Edward Hudson Hudson-, Bart., J.P. 11, *Merrion-square, North, Dublin.*
1868. Jan. 13	Kinahan, George Henry, F.R.G.S.I., Geological Survey of Ireland. 132 *Leinster-road, Rathmines.*
1863. April 13	Kinahan, Thomas W., M.A. 24, *Waterloo-road, Dublin.*
1883. April 9	King, Henry, M.A. M.B., Deputy Surgeon-General. 52 *Lansdowne-road, Dublin.*
1885. Dec. 14	King, Lucas White. *Ajmere, India.*
1883. Feb. 12	Knott, John Freeman, M.B., F.R.C.S.I. 34, *York-street, Dublin.*
1883. Dec. 10	Knowles, W. J. *Flixton-place, Ballymena.*
1837. Feb. 13	*§Knox, George J. 29, *Portland-terrace, Regent's Park, London, N.W.*
1864. April 11	*Lalor, John J., F.R.G.S.I. *City Hall, Cork-hill, Dublin.*
1864. Jan. 11	LaTouche, J. J. Digges, M.A. LL.D. 1, *Ely-place, Upper, Dublin.*
1857. April 13	*Leach, Lieut.-Colonel George A., R.E. 3, *St. James's-square, London, S.W.*
1845. Feb. 10	*LeFanu, William R., C.E. *Summerhill, Enniskerry, Co. Wicklow.*
1846. May 11	**Lefroy, George.*
1876. Feb. 14	*Leinster, His Grace Gerald, Duke of. *Carton, Maynooth.*
1869. April 12	*Lenihan, Maurice, J.P. *Limerick.*
1886. June 28	Lentaigne, John Vincent, B.A. (Dub.), F.R.C.S.I. L.K.Q.C.P.I. 29, *Westland-row, Dublin.*
1870. June 13	Leonard, Hugh, F.G.S., F.R.G.S.I. 2, *Herbert-terrace, Blackrock, Co. Dublin.*
1868. April 27	*Little, James, M.D., L.R.C.S.I., F.K.Q.C.P.I. 14, *Stephen's-green, North, Dublin.*
1846. Jan. 12	**Lloyd, William T., M.D.*
1875. April 12	Lombard, James F., J.P. *South-hill, Rathmines, Co. Dublin.*

Date of Election.	
1883. Feb. 12	Longfield, Thomas H. 19, *Harcourt-street, Dublin.*
1878. Feb. 11	*Lowry, Robert William, B.A. (Oxon.) D.L. *Pomeroy House, Dungannon, Co. Tyrone.*
1868. Jan. 13	Lyne, Robert Edwin. *Royal Dublin Society, Kildare-street, Dublin.*
1873. April 14	§Macalister, Alexander, M.A. (Cantab.), M.D. (Dub. and Cantab.), F.R.S., Fellow of St. John's College, and Professor of Anatomy in the University of Cambridge. *Strathmore House, Cambridge.*
1871. Feb. 13	*Macartney, J. W. Ellison, J.P., D.L. *The Palace, Clogher.*
1884. May 12	§*MacCarthy, Rev. Bartholomew, D.D. *Nelson-place, Youghal, Co. Cork.*
1881. June 27	McClintock, Rev. Francis Le Poer, M.A. (Cantab.), *Spencer Hill, Castlebellingham, Co. Louth.*
1874. Feb. 9	McClure, Rev. Edmund, M.A., Society for Promoting Christian Knowledge. *Northumberland-avenue, London, W.C.*
1873. Jan. 13	*McCready, Rev. Christopher, M.A. 56, *High-street, Dublin.*
1864. April 11	*McDonnell, Alexander, M.A., C.E., F.R.G.S.I. *Saltwell Hall, Gateshead-on-Tyne.*
1845. Feb. 24	**Macdonnell, James S., C.E.*
1827. Mar. 16	*MacDonnell, John, M.D., F.R.C.S.I., F.R.G.S.I. 32, *Upper Fitzwilliam-street, Dublin.*
1857. Feb. 9	*§McDonnell, Robert, M.D., F.R.C.S.I., F.R.S. 89, *Merrion-square, West, Dublin.*
1882. Feb. 13	McHenry, Alexander, Geological Survey of Ireland. 54, *Serpentine-avenue, Sandymount, Co. Dublin.*
1881. Feb. 14	§Mackintosh, Henry William, M.A., Professor of Zoology and Comparative Anatomy in the University of Dublin. *Trinity College, Dublin.*
1871. April 10	Macnaghten, Colonel Sir Francis Edmund, Bart. (Late 8th Hussars), D.L. *Dundarave, Bushmills, Co. Antrim.*
1874. April 13	MacSwiney, Stephen Myles, M.D. 9, *Upper Merrion-street, Dublin.*
1884. Jan. 14	McTernan, Rev. Stephen, P.P. *Killasnet, Manorhamilton.*
1888. May 14	Mahony, James A. *Ramelton, Co. Donegal.*
1882. April 10	Mahony, Richard John, B.A. (Oxon.) D.L. *Dromore Castle, Kenmare, Co. Kerry.*
1874. Feb. 9	§Malet, John Christian, M.A. F.R.S., Assistant Commissioner, Intermediate Education Board for Ireland. 1 *Hume-street, Dublin.*

Date of Election.	
1865. April 10	*Malone, Rev. Sylvester, P.P., F.R.H.A.A.I. *Clare Castle, Co. Clare.*
1859. Jan. 10	*Manchester, His Grace William Drogo, Duke of. 1, *Great Stanhope-street, London; Kimbolton Castle, St. Neot's, Hunts; The Castle, Tandragee.*
1879. Feb. 10	Meldon, Austin, M.D. 15, *Merrion-square, North, Dublin.*
1887. Dec. 12	Milligan, Seaton Forrest. 1 *Royal-terrace, Belfast.*
1884. May 12	*Molloy, William Robert. 17 *Brookfield-terrace, Donnybrook.*
1887. Jan. 10	Moore, Frederick W. *Royal Botanic Garden, Glasnevin.*
1861. Jan. 14	Monck, Right Hon. Charles Stanley, Viscount, G.C.M.G., Lieutenant of Dublin City and County. *Charleville, Bray, Co. Wicklow.*
1869. Feb. 8	*Moran, His Eminence Patrick F., Cardinal, D.D., Archbishop of Sydney. *New South Wales.*
1866. April 9	*More, Alexander Goodman, F.L.S., Soc. Zoo. Bot. Vindob. Socius. 77 *Leinster-road, Rathmines, Co. Dublin.*
1874. Feb. 9	§Moss, Richard J., F.C.S., F.I.C. *St. Aubyns, Ballybrack, Co. Dublin.*
1888. Feb. 13	Mulcahy, Rev. David B., P.P. *Moyarget, Co. Antrim.*
1887. Nov. 14	Mulhall, John. *Viceregal Lodge, Dublin.*
1884. May 12	*Murphy, Rev. Denis, S.J. *University College, Stephen's-green, Dublin.*
1876. April 10	Myers, Walter. 21, *Queensboro-terrace, Hyde-park, London.*
1844. June 8	*Neville, John, C.E., F.R.G.S.I. 71, *Lower Baggot-street, Dublin.*
1887. May 9	*Nichols, Albert Russell, B.A. (Cantab.) *Science and Art Museum, Dublin.*
1873. Jan. 13	Nolan, Joseph, F.R.G.S.I., Geological Survey of Ireland. 21, *Frankfort-avenue, Rathgar, Co. Dublin.*
1846. Jan. 12	*Nugent, Arthur R. *Portaferry, Co. Down.*
1887. Dec. 12	O'Brien, Rev. Francis, P.P. *Cappoquin.*
1869. June 14	*O'Brien, James H. *St. Ita's, Newtownpark, Blackrock, Co. Dublin.*
1875. Jan. 11	O'Callaghan, J. J., F.R.I.A.I. 31, *Harcourt-street, Dublin.*
1867. June 10	O'Conor Don, Right Hon. The, D.L. *Granite Hall, Kingstown.*

Date of Election.	
1867. Jan. 14	O'Donel, Charles J., J.P. 47, *Lower Leeson-street, Dublin.*
1865. Apr. 10	O'Donnavan, William J., LL.D. 79 *Kenilworth-square, Rathgar, Co. Dublin.*
1869. Apr. 12	O'Ferrall, Ambrose More, J.P., D.L. *Balyna House, Enfield, Co. Kildare.*
1866. Jan. 8	*O'Grady, Edward S., B.A., M.B., M. Ch., F.R.C.S.I. 33, *Merrion-square, Dublin.*
1866. June 25	O'Hagan, Hon. John, M.A., Judge of the Supreme Court of Judicature in Ireland, and Judicial Commissioner Irish Land Commission. 22, *Upper Fitzwilliam-street, Dublin.*
1869. Apr. 12	O'Hanlon, Very Rev. (Canon) John, P.P. *Sandymount, Co. Dublin.*
1878. Feb. 11	O'Hanlon, Michael, L.K.Q.C.P.I. *Castlecomer, Co. Kilkenny.*
1869. Apr. 12	O'Laverty, Rev. James, P.P. *Holywood, Co. Down.*
1876. Feb. 14	Olden, Rev. Thomas, B.A. *Ballyclough Vicarage, Mallow, Co. Cork.*
1871. Apr. 10	O'Looney, Brian, F.R.H.S. *Grove-villa House, Crumlin, Co. Dublin.*
1861. June 10	*O'Mahony, Rev. Thaddeus, D.D. *Trinity College, Dublin.*
1884. May 12	O'Meagher, Joseph Casimir. 45, *Mountjoy-square, Dublin.*
1882. Nov. 13	O'Reardon, John Frazer. 7, *Pembroke-road, Dublin.*
1886. April 12	*O'Reilly, Henry Thomas, F.R.C.S.I. 58, *Park-avenue, Sandymount, Co. Dublin.*
1870. Jan. 10	§O'Reilly, Joseph P., C.E., Prof. of Mining and Mineralogy, Royal College of Science, Dublin, Secretary of Foreign Correspondence of the Academy. 58, *Park-avenue, Sandymount, Co. Dublin.*
1879. May 12	O'Rorke, Very Rev. Terence, D.D., P.P. *Collooney, Sligo.*
1888. Dec. 10	*Orpen, John Herbert, LL.D. 58, *Stephen's-green, East, Dublin.*
1866. Jan. 8	*O'Sullivan, Daniel, Ph. D. 3 *Longford-terrace, Kingstown.*
1873. Feb. 10.	Patterson, William Hugh. *Garranard, Strandtown, Co. Down.*
1884. Feb. 11	Pearsall, William Booth, F.R.C.S.I. 13, *Upper Merrion-street, Dublin.*
1847. Feb. 8	*Pereira, Rev. Henry Wall, M.A., F.S.A. Scot. *Wells, Somerset.*

Date of Election.	
1863. Apr. 13	*Pigot, David R., M.A., Master, Court of Exchequer. *Churchtown House, Dundrum, Co. Dublin.*
1870. Apr. 11	Pigot, Thomas F., C.E., Prof. of Descriptive Geometry, Royal College of Science, Dublin. 4, *Wellington-road, Dublin.*
1886. Feb. 8	Pim, Greenwood, M.A. *Easton Lodge, Monkstown, Co. Dublin.*
1884. Feb. 11	Plunkett, George Noble, Count of the Roman States, 26 *Upper Fitzwilliam-street, Dublin.*
1880. Feb. 9	Plunkett, Thomas, F.R.G.S.I. *Enniskillen.*
1864. Jan. 11	**Poore, Major Robert.*
1862. Apr. 14	*Porte, George. 43, *Great Brunswick-street, Dublin.*
1873. Jan. 13	*Porter, Alexander, M.D., F.R.C.S., Indian Army. *Madras.*
1875. Jan. 11	Porter, Sir George Hornidge, M.D., M.Ch., Surgeon in Ordinary to the Queen in Ireland. 3, *Merrion-square, North, Dublin.*
1873. Jan. 13	Powell, George Denniston, M.D., L.R.C.S.I. 76, *Upper Leeson-street, Dublin.*
1875. April 12	*Powerscourt, Right Hon. Mervyn, Viscount, K.P. *Powerscourt, Enniskerry, Bray.*
1874. Dec. 14	*Purcell, Mathew John, J.P. *Stephen's-green Club, Dublin.*
1858. Jan. 11	Purser, John, M.A., D.Sc., LL.D (Edin.), Professor of Mathematics. *Queen's College, Belfast.*
1884. June 23	Purser, Louis Claude, M.A., F.T.C.D. 11 *Harcourt-terrace*
1881. Apr. 11	*Quinlan, Francis John Boxwell, B.A., M.D., F.K.Q.C.P.I. 29 *Lower Fitzwilliam-street, Dublin.*
1884. May 12	Ramsay, Edward P., F.L.S., C.M.Z.S., Curator of the Australian Museum. *Sydney, Australia.*
1867. Jan. 14	*Read, John M., General, U.S. Army; Consul-General of the U. S. A. for France and Algeria, Member of American Philoso. Soc., Fellow of the Royal Soc. of Northern Antiquaries. *Athens.*
1846. Dec. 14	*§Reeves, Right Rev. William, D.D., M.B., LL.D., Lord Bishop of Down, Connor, and Dromore. *Conway House, Dunmurry, Co. Antrim.*
1843. Feb. 13	*§*Renny, Henry L., F.R.G.S.I., late Lieut. R.E.*
1878. June 24	*Reynell, Rev. William A., B.D. 8, *Henrietta-street, Dublin.*
1887. June 27	Robinson, Hugh. 82, *Donegall-street, Belfast.*
1881. Jan. 10	Robinson, John L., C.E. M.R.I.A.I. *Rathruadh, Glenageary, Co. Dublin.*
1844. June 10	*Roe, Henry, M.A. *Isle of Man.*

Date of Election.	
1876. Jan. 10	*Ross, Rev. William. 163 *Hill-street, W., Glasgow.*
1870. Nov. 30	Rosse, Right Hon. Lawrence, Earl of, D.C.L., D.L., F.R.S. F.R.A.S. *Birr Castle, Parsonstown.*
1885. Dec. 14	*Rylands, Thomas Glazebrook, F.S.A., F.R.A.S., F.C.S. *Highfields, Thelwall, near Warrington.*
1843. Jan. 9	*§Salmon, Rev. George, D.D. (Dub. and Edin.), D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., and Royal Medalist, 1868, Provost of Trinity College. *Provost's House, Trinity College, Dublin.*
1853. Jan. 10	*Sanders, Gilbert. *Albany Grove, Monkstown, Co. Dublin.*
1884. Dec. 8	Sankey, Lieutenant-General Richard H., C.B., R.E., *Floraville, Eglinton-road, Dublin.*
1888. Feb. 13	Scharff, Robert F., B.Sc., Ph.D. *Science and Art Museum, Dublin.*
1888. April 9	Sellors, Edward Marmaduke, M.A. 10 *St. Mary's-road, Dublin.*
1887. June 13	*Semple, James C. 64 *Grosvenor-road, Rathgar, Co. Dublin.*
1846. Feb. 9	*Sherrard, James Corry. 7, *Oxford-square, Hyde-park, London.*
1869. Apr. 12	Sigerson, George, M.D., M.Ch., F.L.S., F.R.U.I., Prof. of Botany, Catholic University. 3, *Clare-street, Dublin.*
1835. Feb. 23	*§Smith, Aquilla, M.D., F.K.Q.C.P.I. 121, *Lower Baggot-street, Dublin.*
1877. Dec. 10	*Smith, Charles. *Barrow-in-Furness.*
1868. Jan. 13	Smith, John Chaloner, C.E., *Engineer's Office, Dublin, Wicklow, and Wexford Railway, Bray.*
1876. June 26	Smith, Rev. Richard Travers (Canon), D.D. *The Vicarage, Clyde-road, Dublin.*
1887. Jan. 10	Sollas, William Johnson, M.A., D. Sc. (Cantab), LL.D. (Dub.), Professor of Geology, University of Dublin. 4 *Clyde-road, Dublin.*
1874. Dec. 14	Stewart, James, M.A. (Cantab.), Professor of Greek and Latin, Catholic University. 21, *Gardiner's-place, Dublin.*
1871. June 12	§Stokes, Whitley, LL.D., C.S.I. 15, *Grenville-place, Cornwall Gardens, London, S. W.*
1857. June 8	*§Stoney, Bindon B., M.A., LL.D., C.E., F.R.S., F.R.G.S.I., 14, *Elgin-road, Dublin.*
1856. Apr. 14	*§Stoney, George Johnstone, M.A., D.Sc., F.R.S., 9 *Palmerston-park, Upper Rathmines.*
1857. Aug. 24	*Sullivan, William Kirby, Ph.D., President of Queen's College, Cork. *Queen's College, Cork.*

Date of Election.	
1871. Jan. 9	Symons, John. 72, *Queen-street, Hull.*
1877. April 9	§Tarleton, Francis Alexander, LL.D., F.T.C.D. 24, *Upper Leeson-street, Dublin.*
1869. Apr. 12	§Tichborne, Charles Roger C., Ph.D., F.C.S. 15, *North Great George's-street, Dublin.*
1876. April 10	*Tyrrell, George Gerald, Clerk of the Crown, Co. Armagh. 30, *Upper Pembroke-street, Dublin; Banbridge, Co. Down.*
1870. Nov. 30	Ventry, Right Hon. Dayrolles Blakeney, Baron, D.L. *Burnham-house, Dingle, Co. Kerry.*
1880. Feb. 9	Vesey, Agmondisham B., L.K.Q.C.P.I. *Bellevue, Magherafelt.*
1888. Feb. 13	Walpole, George. *Windsor Lodge, Monkstown, Co. Dublin.*
1884. May 12	Walsh, Most Rev. William J., D.D., Lord Archbishop of Dublin. *Rutland-square, Dublin.*
1881. Feb. 14	*Ward, Francis Davis, J.P., *Clonaver, Strandtown, Co. Down.*
1864. Feb. 8	*Warren, James W., M.A. 39, *Rutland-square, West, Dublin.*
1881. Jan. 10	*Watts, Robert George, M.D., F.R.S.L., *Albion House, Quadrant-road, Canonbury, London, N.*
1866. Apr. 9	Westropp, W. H. Stacpoole, L.R.C.S.I., F.R.G.S.I., *Lisdoonvarna, Co. Clare.*
1880. Feb. 9	*White, John Newsom. *Rocklands, Waterford.*
1851. Jan. 13	*Whittle, Ewing, M.D., M.R.C.S.E. 1, *Parliament-terrace, Liverpool.*
1874. June 8	Wigham, John R. 35, *Capel-street, Dublin.*
1873. April 14	Wilkinson, Thomas. *Enniscorthy, Co. Wexford.*
1839. Jan. 14	*Williams, Richard Palmer, F.R.G.S.I. 38, *Dame-street, Dublin.*
1837. Jan. 9	*Williams, Thomas. 38, *Dame-street, Dublin.*
1877. April 9	Williamson, Benjamin, M.A., F.R.S., F.T.C.D. Professor of Natural Philosophy, University of Dublin. 1, *Dartmouth-road, Dublin.*
1888. June 25	*Wilson, Wesley William, C.E. *St. James's-gate, Dublin.*
1888. June 25	*Wilson, William Edward. *Daramona, Streete, Rathowen, Co. Dublin.*
1884. May 12	Wood-Martin, Lieutenant-Colonel William Gregory, J.P. *Cleveragh, Sligo.*
1857. Aug. 24	*§Wright, Edward Perceval, M.A., M.D. (Dub.), M.A. (Oxon.), F.L.S., F.R.C.S.I., J.P., Professor of Botany and Keeper of the Herbarium, University of Dublin, Secretary of the Academy. 5 *Trinity College.*

HONORARY MEMBERS.

Date of Election.	
1863. June 22	HIS ROYAL HIGHNESS ALBERT EDWARD, PRINCE OF WALES.

"*The* PRESIDENT OF THE ROYAL SOCIETY, AND EX-PRESIDENTS *of the same, are always considered Honorary Members of the Academy.*"—By-Laws, ii., 14.

1869. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Hooker, Sir Joseph Dalton, K.C.S.I., M.D., C.B., F.R.S., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Kew, London, W.*
1832. Nov. 30 (Elected Hon. Mem. in Sec. of Science originally.)	Airy, Sir George Biddell, K.C.B., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Playford, near Ipswich.*
1874. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Huxley, Thomas Henry, D.C.L., LL.D., M.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *London.*
1873. Mar. 15 (Elected Hon. Mem. in Sec. of Science originally.)	Stokes, George Gabriel, D.C.L., LL.D., PRESIDENT OF THE ROYAL SOCIETY. *Lensfield Cottage, Cambridge.*

SECTION OF SCIENCE.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

1873. Mar. 15	Adams, John Couch, LL.D. (Dub.), F.R.S. *The Observatory, Cambridge.*
1874. Mar. 16	Berthelot, Marcelin Pierre Eugène, F.R.S. *Boulevard Saint-Michel,* 57, *Paris.*
1875. Mar. 16	Bertrand, Joseph Louis François, F.R.S. *Paris.*
1869. Mar. 16	Brown-Séquard, Charles Edouard, M.D., LL.D. (Cantab.), F.R.S. *Collège de France, Rue Soufflot.*
1869. Mar. 16	Bunsen, Robert Wilhelm Eberard. *Heidelberg.*
1869. Mar. 16	Carus, J. Victor. *Leipzig.*
1873. Mar. 15	Cayley, Arthur, D.C.L., LL.D. (Dub.), F.R.S. *Garden House, Cambridge.*
1883. Mar. 16	Charcot, J. *Paris.*
1866. Mar. 16	Clausius, Rudolf Julius Emmanuel, F.R.S. *Bonn.*
1873. Mar. 15	Dana, James Dwight, LL.D., F.R.S. *Yale College, New Haven, Conn., U. S. America.*
1869. Mar. 16	Daubrée, Gabriel Auguste, F.R.S. 254 *Boulevard St. Germain, Paris.*
1876. Mar. 16	DeCandolle, Alphonse, F.R.S. *Geneva.*
1886. Mar. 16	Frankland, Edward, M.D., D.C.L., LL.D., F.R.S. *The Yews, Reigate Hill, Reigate.*

HONORARY MEMBERS—*Continued.*

SECTION OF SCIENCE—Continued.

Date of Election.	
1876. Mar. 16	Haeckel, Ernst. *Jena.*
1864. Mar. 16	Helmholtz, Hermann Ludwig Ferdinand Von, F.R.S. *Berlin.*
1884. Mar. 15	Hermite, Charles, F.R.S. 2 *Rue de Sorbonne, Paris.*
1873. Mar. 15	Hofmann, August Wilhelm, F.R.S. *Berlin.*
1879. Mar. 16	Huggins, William, D.C.L., LL.D., F.R.S. *Upper Tulse-hill, London, S.W.*
1864. Mar. 16	Hyrtl, Karl Joseph. *Vienna.*
1880. Mar. 16	Loomis, Elias. *Yale College, Conn., U. S. America.*
1880. Mar. 16	Marsh, O. C. *Yale College, Conn., U. S. America.*
1882. Mar. 16	Newcomb, Simon, F.R.S. *Washington.*
1884. Mar. 16	Nordenskjöld, Baron Adolf Erik de. *Stockholm.*
1878. Mar. 16	Pasteur, Louis, F.R.S. *Paris.*
1886. Mar. 16	Rayleigh, Rt. Hon. John William, Lord, M.A., D.C.L., LL.D., F.R.S., Secretary of the Royal Society. *Terling-place, Witham, Essex.*
1885. Mar. 16	Sylvester, James Joseph, D.C.L., LL.D., F.R.S., *Oxford.*
1878. Mar. 16	Thomson, Sir William, LL.D., D.C.L. (Oxon.) F.R.S. *Glasgow.*
1882. Mar. 16	Virchow, Rudolph, F.R.S. *Berlin.*
1885. Mar. 16	Williamson, Alexander William, LL.D., F.R.S., 28 *Primrose-hill-road, London, N.W.*

(*One vacancy.*)

SECTION OF POLITE LITERATURE & ANTIQUITIES.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

Elected in the Department of Polite Literature.

Date of Election.	
1869. Mar. 16	Gayangos y Arce, Don Pascual de. *London.*
1869. Mar. 16	Lassen, Christian. *Bonn.*
1849. Nov. 30	Lepsius, Karl Richard. *Berlin.*
1869. Mar. 16	Mommsen, Theodor. *Berlin.*
1863. Mar. 16	Müller, Max, M.A. *Oxford.*

Elected in the Department of Antiquities.

1869. Mar. 16	Benavides, Don Antonio. *Madrid.*
1848. Nov. 30	Botta, Paul Emile. *Paris.*
1867. Mar. 16	De Rossi, Commendatore Giovanni Battista. *Rome.*
1841. Mar. 16	Halliwell-Phillipps, James Orchard, F.R.S., F.SS.A. Lond. & Scotland. *Hollingbury Copse, Brighton.*
1854. Mar. 16	Maury, Louis Ferdinand Alfred. *Paris.*
1867. Mar. 16	Visconti, Barone Commendatore P. E. *Rome.*

Elected since the union of the two classes of Honorary Members in this Section.

1888. Mar. 16	Anderson, Joseph, LL.D. *Edinburgh.*
1882. Mar. 16	Ascoli, Graziadio I. *Milan.*
1882. Mar. 16	Bond, Edward Augustus, C.B., LL.D., Principal Librarian of the British Museum. *London.*
1882. Mar. 16	Brugsch-Pascha, Heinrich. *Berlin.*
1883. Mar. 16	Evans, John, LL.D., D.C.L., Fellow and Treasurer Royal Society, *London.*
1875. Mar. 16	Franks, Augustus Wollaston, M.A., F.R.S., F.S.A. 103, *Victoria-street, London, S. W.*
1880. Mar. 16	Fick, F. C. August. *Göttingen.*
1878. Mar. 16	Kern, H. *Leyden.*
1886. Mar. 16	Newman, His Eminence John Henry Cardinal, D.D. *Birmingham.*
1878. Mar. 16	Newton, Charles, C.B., D.C.L., F.S.A. *British Museum, London.*

Date of Election.	
1873. Mar. 15	Nigra, His Excellency Cavaliere Constantino, Italian Minister to Russia. *St. Petersburg.*
1886. Mar. 16	Schliemann, Heinrich, D.C.L. *Athens.*
1884. Mar. 15	Stephens, George. *Copenhagen.*
1876. Mar. 16	Stokes, Margaret. *Carrig-Breac, Howth, Co. Dublin.*
1876. Mar. 16	Stubbs, Right Rev. William, D.D., Lord Bishop of Chester. *Chester.*
1873. Mar. 15	Westwood, John Obadiah, F.S.A. *Oxford.*
1875. Mar. 16	Whitney, William Dwight. *Yale College, Conn. U.S. America.*
1876. Mar. 16	Windisch, Ernst. *Leipzig.*

(One vacancy.)

SUMMARY.

Life Members,	...	...	...	138
Annual Members,	...	...	...	164
				302
Honorary Members (58 + 5),		...	...	63
		Total,	...	365

Should any errors or omissions be found in this List, which is revised to 1st July, 1888, it is requested that notice thereof may be given to the Secretary of the Academy. He should also be informed of the death of any Member.

R. D. Webb and Son, Printers, 74 Abbey-street, Dublin.

Royal Irish Academy.

GENERAL ABSTRACT OF THE ACCOUNTS,

FROM

1st April, 1889, to 31st March, 1890.

GENERAL ABSTRACT OF THE ACCOUNT OF REV. MAXWEL

FOR THE YEAR ENDI

RECEIPTS.	For Special Purposes.	For General Purposes.	Total of each Class.
	£ s. d.	£ s. d.	£ s. d.
Balance from last Year,	248 10 8	91 1 8	339 12 4
FROM PARLIAMENTARY GRANTS:—			
Unappropriated:—"Old Grant,"	. . .	500 0 0	
Appropriated:—			
Preparation of Scientific Reports, . . .	200 0 0		
Library, ...	200 0 0		
Researches in connexion with Celtic MSS.,	200 0 0		
Publication of ditto, ...	200 0 0		
Museum, ...	200 0 0		
Purchase of Treasure Trove, ...	100 0 0		
Illustration and Printing of "Transactions" and "Proceedings,"	200 0 0		
Opening the Academy in the evening, . .	200 0 0		
			2000 0 0
" TODD MEMORIAL FUND:—			
Interest on Investments, ...	49 10 0	. . . . .	49 10 0
" MEMBERS' PAYMENTS:—			
Entrance Fees, ...	. . . . .	47 5 0	
Annual Subscriptions, ...	. . . . .	336 0 0	
Life Membership Compositions (*invested as opposite*), ...	162 11 5		
			545 16 5
" PUBLICATIONS SOLD:—			
Transactions, ...	. . . . .	40 14 0	
Proceedings, ...	. . . . .	10 5 6	
Book of Leinster, ...	. . . . .	9 9 0	
Leabhar Breac, ...	. . . . .	6 4 0	
Leabhar na h-Uidhri, ...	. . . . .	4 4 0	
Book of Ballymote, ...	. . . . .	33 12 0	
Todd Lectures, Vol. II., ...	. . . . .	7 9 0	
Museum Catalogue (*invested as opposite*),*	1 8 4	. . . .	
Photographs of Objects in the Museum, .	. . . . .	3 10 3	
			116 16 1
" INTEREST ON INVESTMENTS:—			
Life Composition—2¾ per cent. Consol. Stock,	. . . . .	96 2 2	
Cunningham Bequest, 2¾ per cent. Consol. Stock, ...	94 3 10		
Museum Catalogue—Bank of Ireland Stock (*invested as opposite*),*	7 14 4		
Pecuniary Premium Fund — 2¾ per cent. Consol. Stock, ...	2 13 4		
			200 13 8
" Annals of Ulster—Repayment by the Treasury of the Amount paid last Year by the Academy for Editing and Printing,	. . . . .	24 7 6	24 7 6
	£2066 11 11	1210 4 1	3276 16 0

I certify that the above account is correct, according to the best of m

ADEMY.

CLOSE, TREASURER OF THE ROYAL IRISH ACADEMY,

OF MARCH, 1890.

PAYMENTS.	From Funds appropriated for Special Purposes.	From Funds available for General Purposes.	Total of each Class.
	£ s. d.	£ s. d.	£ s. d.
For SCIENTIFIC AND LITERARY PURPOSES:—			
Scientific Reports,	200 0 0		
Library,	200 0 0	116 9 3	
Irish Scribe, &c.,	200 0 0		
" (including Photo-Lithographing of Yellow Book of Lecan),	200 0 0		
Museum,	200 0 0	20 8 5	
Treasure Trove	129 9 6		
"Transactions" and "Proceedings,"	200 0 0	244 15 6	
Opening the Academy in the evening,	200 0 0	8 17 3	
"Cunningham Memoirs,"	140 0 0		
			2059 19 11
" ESTABLISHMENT CHARGES:—			
Salaries,	. . . .	369 0 0	
Wages and Liveries,	. . . .	193 15 11	
Furniture and Repairs,	. . . .	9 19 3	
Fuel,	. . . .	24 11 2	
Insurance,	. . . .	8 2 6	
Stationery,	. . . .	6 4 9	
Printing (Miscellaneous),	. . . .	42 6 0	
Postage,	. . . .	17 7 3	
Freights, Incidentals, and Contingencies,	. . . .	58 17 9	
			730 4 7
" INVESTMENTS (CAPITAL):—			
Life Membership Compositions,*	27 6 0		
Mus. Catalogue,*	8 0 8		
			35 6 8
" Balance to Credit,	363 16 8	75 4 7	439 1 3
	£2068 12 10	1195 19 7	3264 12 5

	Stock Bought. £	s.	d.	Description.	Total Stock. £	s.	d.
Life Membership Compositions,*	27	19	10	Consol. Stock,	3477	18	3
Mus. Catalogue,*	2	9	10	Bk. of Ir. Stock,	75	10	10

DETAILS OF APPROPRIATED BALANCE.

	£	s.	d.
Treasure Trove,	£108	15	8
Cunningham Fund,	107	5	10
Pecuniary Premium Fund,	14	4	6
Todd Memorial Fund,	133	10	8
	£363	16	8

owledge and belief.—Maxwell H. Close, *Treasurer, R.I.A.*—*May* 14, 1890.

[*For Auditors' Report see next page.*

AUDITORS' REPORT.

We have examined the above General Abstract, and compared the Vouchers for the details of the several heads thereof, and find the same to be correct, leaving a Balance to the credit of the Academy of Four Hundred and Thirty-nine Pounds One Shilling and Three Pence.

The Treasurer has also exhibited to us Certificates in respect of the invested *Capital*, showing that the amounts of Stock standing in the name of the Academy were £2653 9*s*. 9*d*., Two-and-three-quarters per Cent. Consolidated Government Stock, being the Capital of the "Cunningham Fund"; £3477 18*s*. 3*d*. Two-and-three-quarters per Cent. Consolidated Government Stock, being Capital derived from Life Compositions; and £75 10*s*. 10*d*., Bank of Ireland Stock.

Like Certificates have been exhibited to us showing two sums amounting together to £142 2*s*. 4*d*., Consolidated Government Stock, standing in the names of Trustees, which, with the sum of £1209 18*s*. 4*d*., Consolidated Government Stock, in the Court of Chancery, form the Invested Capital of the "Todd Memorial Fund."

(Signed), { WILLIAM FRAZER, J. J. DIGGES LA TOUCHE, } *Auditors*.

June 6, 1890.

Royal Irish Academy.

GENERAL ABSTRACT OF THE ACCOUNTS,

FROM

1st April, 1887, to 31st March, 1888.

ROYAL IRISH

GENERAL ABSTRACT OF THE ACCOUNT OF REV. MAXWEL

FOR THE YEAR ENDI

RECEIPTS.	For Special Purposes.	For General Purposes.	Total of each Class.
	£ s. d.	£ s. d.	£ s. d.
From PARLIAMENTARY GRANTS:—			
Unappropriated:—"Old Grant,"	. . . .	500 0 0	
Appropriated:—			
Preparation of Scientific Reports, . . .	200 0 0		
Library, ...	200 0 0		
Researches in connexion with Celtic MSS.,	200 0 0		
Publication of ditto, ...	200 0 0		
Museum, ...	200 0 0		
Purchase of Treasure Trove, ...	100 0 0		
Illustration and Printing of "Transactions" and "Proceedings,"	200 0 0		
Opening the Academy in the evening, . .	200 0 0		
			2000 0 0
,, SCIENCE GRANT:— Returned by Grantees, ...	10 0 0	. . . .	10 0 0
,, TODD MEMORIAL FUND:— Interest on Investments, ...	39 8 5	. . . .	39 8 5
,, ACADEMY CENTENARY FUND:— Balance from, ...	34 7 4	. . . .	34 7 4
,, MEMBERS' PAYMENTS:—			
Entrance Fees, ...	. . . .	78 15 0	
Annual Subscriptions, ...	. . . .	306 12 0	
Life Membership Compositions (*invested as opposite*), ...	69 6 0		
			454 13 0
,, PUBLICATIONS SOLD:—			
Transactions, ...	. . . .	57 3 11	
Proceedings, ...	. . . .	20 1 3	
Book of Ballymote, ...	. . . .	55 1 0	
Todd Lectures, Vol. II., ...	. . . .	11 6 4	
Museum Catalogue (*invested as opposite*),	2 10 6		
			146 3 0
,, INTEREST ON INVESTMENTS:—			
Life Composition—Consol. Stock, . . .	. . . .	93 16 2	
Cunningham Bequest, New 3 per cent. Stock, ...	74 19 7		
Museum Catalogue—Bank of Ireland Stock (*invested as opposite*), ...	7 7 4		
Pecuniary Premium Fund—New 3 per cent. Stock, ...	2 2 8		
			178 5 9
,, Annals of Ulster—Repayment by the Treasury of the Amount paid last Year by the Academy for Editing and Printing,	258 13 0	. . . .	258 13 0
Account of last year—Amount unaccounted for [see Auditor's Report], ...	. . . .	0 15 0	0 15 0
	£1998 14 10	1123 10 8	3122 5 6

I certify that the above account is correct, according to the best of my

ADEMY.

LOSE, TREASURER OF THE ROYAL IRISH ACADEMY,

OF MARCH, 1888.

PAYMENTS.	From Funds appropriated for Special Purposes.	From Funds available for General Purposes.	Total of each Class.
	£ s. d.	£ s. d.	£ s. d.
Debit Balance from last Year,	145 4 7	24 2 10	169 7 5
For SCIENTIFIC AND LITERARY PURPOSES:—			
Scientific Reports, ...	210 0 0		
Library, ...	200 0 0	48 13 8	
Irish Scribe, &c., ...	200 0 0		
" (including Photo-Lithographing of Book of Ballymote), . . .	200 0 0		
Museum, ...	200 0 0	17 15 10	
Treasure Trove	52 8 0		
"Transactions" and "Proceedings," . .	200 0 0	93 11 0	
Opening the Academy in the evening, . .	200 0 0	2 4 9	
Cunningham Fund:—			
Memoirs, No. IV., ...	28 19 6		
Todd Professorship, ...	0 18 6		
			1654 11 3
" ESTABLISHMENT CHARGES:—			
Salaries, ...	. . . .	374 0 0	
Wages and Liveries, ...	. . . .	223 1 3	
Furniture and Repairs, ...	. . . .	4 11 3	
Fuel, ...	. . . .	32 17 5	
Insurance, ...	. . . .	8 2 6	
Stationery, ...	. . . .	4 3 3	
Printing (Miscellaneous), ...	. . . .	62 16 4	
Postage, ...	. . . .	18 4 2	
Freights, Incidentals, and Contingencies, .	. . . .	70 15 1	
			798 11 3
" Interest to Bank on Overdraft, ...	. . . .	0 6 11	0 6 11
" INVESTMENTS (CAPITAL):—			
...e Membership ...ompositions, .	69 6 0		
...seum Catalogue,	9 17 10		
			79 3 10
, Annals of Ulster, Editing and Printing, .	80 12 6	. . .	80 12 6
Balance to Credit, ...	248 10 8	91 1 8	339 12 4
	£2045 17 7	1076 7 11	3122 5 6

	Stock Bought. £ s. d.	Description.	Total Stock. £ s. d.
...e Membership ...ompositions, .	68 13 3	Consol. Stock,	3289 2 1
...seum Catalogue,	3 4 0	Bk. of Ir. Stock,	70 3 6

DETAILS OF APPROPRIATED BALANCE.

Treasure Trove, ...	£60 9 8
Cunningham Fund, ...	82 6 7
Pecuniary Premium Fund, . .	9 11 3
Todd Memorial Fund, ...	96 3 2
	£248 10 8

...dge and belief.—MAXWELL H. CLOSE, *Treasurer, R.I.A.*

[*For Auditors' Report see next page.*

MONDAY, JANUARY 23, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Rev. Dr. Gwynn read a Paper "On a Syriac MS. of the New Testament in the Library of the Earl of Crawford."

Donations to the Library were announced, and thanks were voted to the Donors.

The following Science Grants, recommended by the Council, were confirmed:—

£10 to Mr. R. Lloyd Praeger, for the investigation of the Post-tertiary Estuarine Deposits of the North of Ireland.

£20 to Mr. W. J. Knowles, to investigate the Prehistoric Remains of the Sand Hills of the Coast of the Northern Counties.

£15 (additional) to Professor O'Reilly, for investigating the Chemical Constitution of the Cambrian Rocks of Bray.

Read Letter from the Rector of the University of Bologna, asking the Academy to send a Representative to be present at the celebration of the completion of the Eighth Century of the University's existence.

It was proposed by the Rev. J. H. Jellett, D.D., Provost of Trinity College, Dublin, seconded by Mr. J. T. Gilbert, and resolved—

"That the President be requested to act as Representative of the Royal Irish Academy at the celebration of the completion of the Eighth Century of the existence of the University of Bologna."

Mr. J. T. Gilbert moved and Mr. W. J. Doherty seconded the following, which was passed:—

"That, as the Four Volumes in the Irish Language, issued by the Academy, are not accompanied by English versions, and as their contents are consequently unavailable to the public, the Council be recommended to consider the matter, and report to the Academy, at its next Stated Meeting, on the practicability of procuring and publishing translations of these books by means of the £400 voted annually to the Academy by the House of Commons for works on Irish MSS.; and also whether, for this object, allocations could be made from the interest of the Cunningham Fund, now at the disposal of the Academy."

MONDAY, FEBRUARY 13, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. John Mulhall signed the Roll, and was admitted a Member of the Academy.

The Most Rev. Bishop John Healy, D.D., LL.D.; Richard C. W. Hill; Rev. David B. Mulcahy, P.P.; Robert F. Scharff, B.SC., PH.D.; and George Walpole, were elected Members of the Academy.

Donations to the Library were announced, and thanks were voted to the Donors.

The following Science grant, recommended by the Council, was confirmed:—

£50 to Professor Haddon, to assist him in the investigation of Coral Reefs.

MONDAY, FEBRUARY 27, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Richard C. W. Hill signed the Roll, and was admitted a Member of the Academy.

The following Science grants, recommended by the Council, were confirmed:—

£10 to Colonel W. G. Wood-Martin, in aid of the Exploration of the newly-discovered Crannog Site in the County of Meath.

£60 to a Committee consisting of Rev. W. S. Green, Mr. J. Wright, Dr. C. B. Ball, and Dr. E. P. Wright, to continue the Deep Sea Investigations to the 1000 fathom depth off the South Coast of Ireland.

On the Motion of Viscount Gough, seconded by Mr. Justice O'Hagan, it was resolved that

"The Academy desires to place on record its deep sense of the great loss which it has sustained by the decease of the Rev. Dr. J. H. Jellett, Provost of Trinity College, who had been for nearly forty-seven years one of its Members, and during which period he had taken a very

active part in the direction of its affairs, as Member and Secretary of its Council, and for more than four years as its President.

"By his death Science has lost one who took a foremost position in its ranks, and who had therein achieved a very high reputation.

"The Academy tenders to Mrs. Jellett and the members of her family its sincerest sympathy in their bereavement."

The Academy, as a mark of respect, then adjourned.

FRIDAY, MARCH 16, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Dr. Robert Scharff signed the Roll, and was admitted a Member of the Academy.

The President declared the Ballot open for the Election of the President and Council for the year 1888–9, and appointed Mr. J. R. Garstin and Mr. J. F. Lombard Scrutineers.

The President declared the Ballot open for the Election of an Honorary Member, and appointed the Treasurer and Secretary Scrutineers.

The Secretary of Council read the following

REPORT OF THE COUNCIL FOR THE YEAR 1887–88.

Since the date of the last Report of the Council the following parts of the *Transactions* have been published:—

Vol. xxix.

Part 1. "On the Plane Sections of the Cylindroid, being the Seventh Memoir on the Theory of Screws." By Sir Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland.

Part 2. "On the Ogam Monument at Kilcolman." By the Right Rev. Charles Graves, D.D., Bishop of Limerick.

Cunningham Memoirs.

No. IV. "Dynamics and Modern Geometry, a New Chapter in the Theory of Screws." By Sir Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland.

Also "A List of the Papers published in the *Transactions*, *Cunningham Memoirs*, and *Irish Manuscript Series* (4to) between the Years 1786 and 1886; with an Appendix giving the Names of the Officers of the Academy from 1785 to 1887, and of those to whom the Academy's Cunningham Gold Medals have been awarded."

Of the *Proceedings*, Part 6 of vol. iv. (Second Series), containing Papers on Science, and Part 8 of vol. ii. (Second Series), containing Papers on Polite Literature and Antiquities, were published in January, 1888.

In the *Todd Lecture Series*, vol. ii., "The Passions and Homilies from the *Leabhar Breac*: Text, Translation, and Glossary." By Robert Atkinson, M.A., LL.D.

In the Department of Science the Contributors are:—Mr. Morgan W. Crofton; Sir Robert Ball; Mr. V. Ball; Dr. Cunningham; Dr. Brooks; Mr. Gore; Mr. Burton; Dr. Bennett; Mr. H. Hennessy; Dr. Tarleton; Mr. Haddon; Mr. Alexander; and Mr. Thomson.

In the Department of Polite Literature and Antiquities:—The Bishop of Limerick; Dr. Frazer; Rev. P. A. Yorke; Rev. Dr. Gwynn.

The following Grants in aid of the Preparation of Scientific Reports have been sanctioned by the Academy:—

£10 to the Rev. T. E. Espin, to assist him in his revision of Birmingham's Red Star Catalogue.

£10 to Mr. Richard P. Vowell, for a Report on the Flora of the Shores and Neighbourhood of Loughs Corrib and Mask.

£25 to Professor J. P. O'Reilly, as an additional grant for a Report on the Constitution of certain Cambrian Rocks.

£10 to Mr. R. Lloyd Praeger, for the investigation of the Post-tertiary Estuarine Deposits of the North of Ireland.

£20 to Mr. W. J. Knowles, to investigate the Prehistoric Remains of the Sand Hills of the Coast of the Northern Counties of Ireland.

£15 (additional) to Professor O'Reilly, for investigating the Chemical Constitution of the Cambrian Rocks of Bray.

£50 to Professor Haddon, to assist him in the investigation of Coral Reefs.

£10 to Colonel W. G. Wood-Martin, in aid of the Exploration of the newly-discovered Crannog Site in the county of Meath.

£60 to a Committee consisting of Rev. W. S. Green, Mr. J. Wright, Dr. C. B. Ball, and Dr. E. P. Wright, to continue the Deep Sea investigations to the 1000 fathom depth off the South Coast of Ireland.

In the past year the study of Celtic has been advanced by the publication of the Lectures of the Todd Professor, during his tenure of office in the years 1885–1887. As his successor in this office, the Rev. Dr. M'Carthy has been appointed, and he will, it is hoped, deliver his first series of Lectures during the incoming Academic year.

The Council have to regret that more progress has not been made with the *Annals of Ulster*, of which the first volume, however, is now available to the public, having been issued by the Stationery Office.

On a motion of Mr. Gilbert, it was referred to the Council to prepare a Report in expression of their opinion as to the practicability of attempting to obtain translations of the Facsimiles of Irish MSS., already published by the Academy; but the Council, after considering the subject, felt that it was too important to be hurried over in the end of the Council session, and therefore recommend the completion of the inquiry to the incoming Council.

Amongst the numerous additions to the Library made during the past year are—a large series of publications presented by the trustees of the British Museum; a number of volumes from the Natural History Department of the British Museum, South Kensington; Catalogue of the Medusæ of the Australian Seas, &c., presented by the trustees of the Australian Museum, &c.

During the past year several objects, some of considerable antiquarian interest, have been added to the collection of the Museum. They comprise implements of bronze, wood, stone; portion of a bell shrine with leather case; a unique gilt bronze ornament, found in the Co. Antrim; an ancient bottle and leather purse, Co. Mayo; and an iron cauldron of remarkable workmanship, found near a crannog in the Co. Cavan.

The following Ordinary Members have been elected since the 16th March, 1887:—

1. Richard A. Gray, C.E.
2. James C. S. Green, M.B.
3. Most Rev. Bishop Healy, D.D., LL.D.
4. Richard C. W. Hill.
5. Seaton F. Milligan.
6. Rev. David B. Mulcahy, P.P.
7. John Mulhall.
8. A. R. Nichols, B.A.
9. Rev. Francis O'Brien, P.P.
10. Hugh Robinson.
11. Robert F. Scharff, B.SC., PH.D.
12. James C. Semple.
13. George Walpole.
14. Rev. Patrick A. Yorke.

We have lost by death, within the year, twelve Members:—

1. Thomas Baldwin, elected June 24, 1872.
2. Sir John Barrington, D.L., elected May 14, 1866.
3. John A. Blake, M.P., elected January 10, 1876.
4. Very Rev. Canon Ulick J. Bourke, P.P., elected January 9, 1871.
5. Right Hon. Lord Clermont, D.L., elected January 11, 1841.
6. Denis Crofton, B.A., elected August 24th, 1857.
7. Rev. John Hewitt Jellett, D.D., Provost of Trinity College, Dublin, elected April 12, 1841.
8. Charles Croker King, M.D., elected June 8, 1845.
9. Right Hon. James Anthony Lawson, LL.D., D.C.L., elected May 11, 1857.
10. George Woods Maunsell, M.A., D.L., elected January 9, 1871.
11. Very Rev. Canon John O'Rorke, P.P., elected June 11, 1866.
12. Lieutenant-General William J. Smythe, F.R.S., elected April 14, 1873.

We have also lost, by death, one Honorary Member in the Section of Polite Literature and Antiquities:—

Sir Henry James Sumner Maine, LL.D., K.C.S.I., F.R.S.

Among the foregoing, Mr. D. Crofton published in our *Transactions* and *Proceedings* several Papers, the titles of which (given below) sufficiently indicate the nature of his studies, though they suggest rather than display his power of grappling with the difficulties of Oriental writings, leaving it to be regretted that more continuous efforts in a similar direction should not have afforded better opportunities of fully judging his manifold attainments.

The following is a list of the Papers by Mr. D. Crofton:—

"On the Collation of a MS. of the Bhagavad-Gîtâ."

"On Vestiges of Ancient Human Habitations in Poole's Cavern, Derbyshire."

"On a Coincidence between a Babylonian Cuneiform Inscription of Nebuchadnezzar and a Passage in the Book of Daniel."

"On the Brick Inscribed in Archaic Characters in the Museum of Trinity College, Dublin."

"Upon a Sculptured Slab from Nineveh, with a Cuneiform Inscription, at Trinity College, Dublin."

The Academy has sustained a very deep loss in the death of the Rev. Dr. Jellett, the late Provost of Trinity College. His name was a household word among us. In how honourable an estimation he was held by the Academy, his election as President during the years 1869–1874 will show. The Academy also appreciated his sterling worth by conferring on him its Cunningham Gold Medal in 1851. And Dr. Jellett reciprocated the esteem of the Academy by a loyal adhesion to it throughout his career. It is worth note that all his Papers, not published in book form, were read before the Academy, and appeared in its *Proceedings*.

His principal mathematical work was a treatise on the *Calculus of Variations*, published in 1850. This valuable treatise furnished a lucid account of the researches of Continental mathematicians on the subject, and removed many of the difficulties and obscurities connected with this branch of science, especially those attaching to it in the writings of its great inventor, Lagrange. The treatise on the *Calculus of Variations* exhibits, in a remarkable manner, the extreme clearness of thought

which was the most striking characteristic of the intellect of Dr. Jellett. Among his other mathematical publications may be especially mentioned those relating to inextensible surfaces, as of great interest and value; as also his book on *Friction*, which was published in 1872; but probably a surer foundation for his scientific reputation will be found in his invention of the beautiful and delicate instrument called the Double-plane Analyser, and in his application, by means of this instrument, of the properties of polarized light to the investigation of the difficult and unsolved problem of the nature of chemical union. The science of chemistry, viewed from the standpoint of mathematical physics, is yet in its infancy, and to trace the connexion between the chemical properties of matter and its primary qualities must be the work of some Newton of the future; but of those who have striven to clear the way for the final discovery, there is probably none who has made a more original and successful attempt than Dr. Jellett. The investigations described in his Paper on Chemical Optics, in which the properties of polarized light are employed to discover the nature and laws of chemical equilibrium, exhibit a remarkable union of theoretical and experimental skill.

It does not come within the scope of this notice to treat of Dr. Jellett's theological writings, which, of course, could not be left out of consideration in any complete estimation of the labours of the late Provost. As a speaker, however, it may be said that he never addressed an audience without making a deep impression by his lucid statement and logical enchainment of the reasons that guided him to a decision on any disputed point; his earnest manner, outspoken without bitterness, his quiet, yet forcible oratory, always rivetted the attention of his hearers; but it was, above all, his transparent truthfulness that was his highest charm; nor can greater praise be given to a man placed in a position of responsibility and authority than this—which can assuredly be said of Dr. Jellett—that, alike, his supporters and his opponents felt and acknowledged him to be always and in all things a man of absolute integrity.

Appended is a list of Dr. Jellett's Papers in the Academy.

Papers published in the *Transactions*:—

"On the Equilibrium and Motion of an Elastic Solid."

"On the Properties of Inextensible Surfaces."

"Researches in Chemical Optics."

Papers published in the *Proceedings*:—

"A Note on Some New Properties of Surfaces of the Second Order."

"On the Equilibrium or Motion of a Molecular System."

"On the Properties of Inextensible Surfaces."

"On the Effect of the Internal Fluidity of the Earth on the Length of the Day."

"On the Reflexion and Refraction of Polarized Light."

"On a New Analysing Prism."

"On a New Optical Saccharometer."

"On a Fluid possessing Opposite Rotatory Powers for Rays at Opposite Ends of the Spectrum."

"On an Optical Method, by means of which the Formation of Definite Chemical Compounds may be in certain cases Determined."

"On Optical Saccharometry, with special reference to an Examination of some Specimens of Sugar Beet grown in Ireland."

"A further Communication on Optical Saccharometry, with special reference to the Sugar Beets grown in Ireland in the year 1872."

"On the question of Chemical Equilibrium."

"On the Chemical Changes which take place in the Potato during the Progress of the Disease."

The Report was adopted.

On the motion of the Secretary of the Academy, seconded by Dr. J. T. Banks, By-Law 6 of Chapter IX. was suspended (for the purpose of the reading of Papers and the admission of Visitors).

Professor Cunningham, M.D., read a Paper "On the Growth of the Brain during Childhood and Adolescence; with some Observations upon Cranio-cerebral Topography. Illustrated by a Series of Models of the Human Brain *in situ*."

By permission of the Academy, Professor Alexander read a Paper by Mr. A. W. Thomson and himself "On Two-nosed Catenaries, and their Application to the Design of Segmental Arches."

The following letter was read:—

"Provost's House,
"*2nd March*, 1888.

"Dear Dr. Wright,

"I write on behalf of my mother and myself to return our sincere thanks to the Royal Irish Academy for the kind resolution passed by them on the 27th ult. Kind and generous as the resolution is, it is doubly valuable and comforting to us when coming from the

Royal Irish Academy, with whom my dear father was so long and so intimately connected.

"I beg to return our heartfelt thanks.

"Very truly yours,

"W. M. JELLETT.

"E. P. WRIGHT, M.D.,
"*Secretary, Royal Irish Academy.*"

The President, on the Report of the Scrutineers, declared the following duly elected as President and Council for the ensuing year:—

PRESIDENT.

REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.

COUNCIL.

Committee of Science.

J. P. O'Reilly, C.E.
John Casey, LL.D., F.R.U.I., F.R.S.
George Sigerson, M.D., F.R.U.I.
Charles R. C. Tichborne, LL.D.
Sir Robert Kane, LL.D., F.R.S.
Edward Perceval Wright, M.D.
Sir Robert. S. Ball, LL.D., F.R.S.
V. Ball, M.A., F.R.S.
F. A. Tarleton, LL.D., F.T.C.D.
Daniel J. Cunningham, M.D.
Benjamin Williamson, M.A., F.R.S., F.T.C.D.

Committee of Polite Literature and Antiquities.

Robert Atkinson, LL.D.
Rev. Maxwell H. Close, M.A.
John Kells Ingram, LL.D., S.F.T.C.D.
William Frazer, F.R.C.S.I.
David R. Pigot, M.A.
Right Hon. Sir Patrick J. Keenan, C.B., K.C.M.G.
P. W. Joyce, LL.D.
John R. Garstin, M.A., F.S.A.
Hon. Mr. Justice O'Hagan, M.A.
John T. Gilbert, F.S.A.

The President, on the report of the Scrutineers, declared Dr. Joseph Anderson duly elected an Honorary Member of the Academy, in the section of Polite Literature and Antiquities.

The President then declared the Ballot open for the election of Officers, and appointed Dr. La Touche and Dr. Sigerson Scrutineers.

Donations to the Library were announced, and thanks were voted to the Donors.

A portrait of the late Dr. R. R. Madden was presented to the Academy by his son, Dr. Thomas More Madden.

It was moved by Dr. W. Frazer, seconded by Dr. J. K. Ingram, and Resolved—

"That the special thanks of the Academy are hereby given to Dr. T. M. Madden for his donation of the portrait of his father, the late Dr. R. R. Madden."

The President, on the Report of the Scrutineers, declared the following duly elected Officers for the ensuing year:—

TREASURER—Rev. M. H. Close, M.A.
SECRETARY—Ed. Perceval Wright, M.D.
SECRETARY OF THE COUNCIL—Robert Atkinson, LL.D.
SECRETARY OF FOREIGN CORRESPONDENCE—Joseph P. O'Reilly, C.E.
LIBRARIAN—John T. Gilbert, F.S.A.
CLERK OF THE ACADEMY—Robert Macalister, LL.B.

The President, under his hand and seal, appointed the following Vice-Presidents for the ensuing year:—

Professor J. P. O'Reilly, C.E.
Right Hon. Sir Patrick J. Keenan, C.B., K.C.M.G.
Hon. Mr. Justice O'Hagan, M.A.
Professor B. Williamson, M.A., F.R.S., F.T.C.D.

The Academy then adjourned.

SPECIAL MEETING.

WEDNESDAY, MARCH 28, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

The following Recommendation was brought down from the Council, in reference to the funded property of the Academy:—

"Resolved, that it be recommended to the Academy to assent to the proposal of the Chancellor of the Exchequer, relative to the transfer of the funds of the Academy (£4005), now in the New Three per Cents., to the Two-and-three-quarters per Cents., and to give assent to the proposal to transfer the funds (£3290) now in Consols likewise."

The Recommendation was approved and adopted.

MONDAY, APRIL 9, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. George Walpole signed the Roll, and was admitted a Member of the Academy.

Mr. George D. Burtchaell, M.A., LL.B., and Mr. Edward M. Sellors, M.A., were elected Members of the Academy.

The Secretary read a Paper by Mr. J. E. Gore, F.R.A.S., "On the Variable Star μ Cephei."

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, APRIL 23, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. G. D. Burtchaell and Mr. E. M. Sellors signed the Roll, and were admitted Members of the Academy.

Sir Patrick Keenan, Vice-President, took the Chair while the President read a Paper "On Geometrical Illustrations of Newlands' and Mendelejeff's Periodic Law of the Atomic Weights of the Chemical Elements. Part I. Hydrogen, and the First and Second Periods following it—1. The Carbon Period; 2. The Silicon Period."

The President having resumed the Chair,

Professor Haddon, M.A., read a Paper entitled "Contributions towards a Revision of the British Actiniæ." Part I.

Donations to the Library were announced, and thanks were voted to the Donors.

The Rev. Dr. Haughton, F.R.S., President, was elected a Representative of the Royal Irish Academy on the Board of Visitors of the Museum of Science and Art, Dublin, in the room of the late Rev. Dr. Jellett.

MONDAY, MAY 14, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. James A. Mahony was elected a Member of the Academy.

Dr. Atkinson, on behalf of the Subscribers, presented to the Academy a Portrait, by Miss Sarah Purser, of the late Sir Samuel Ferguson, President of the Academy. The President, on behalf of the Academy, accepted the same.

Dr. Tarleton took the Chair while the President read a Paper "On Geometrical Illustrations of Newlands' and Mendelejeff's Periodic Law of the Atomic Weights of the Chemical Elements. Part II. The Third and Fourth Periods—3. The Titanium Period; 4. The Germanium Period."

The President having resumed the Chair—

The Secretary read a Paper by Dr. C. G. Young "On the Habits and Anatomy of *Opisthocomus cristatus*."

Dr. Frazer read some Notes on Testoons of Henry VIII., with details of an undescribed Testoon of the Bristol mint, coined by Thomas Sharington.

Dr. Frazer read some Notes on a Powder Flask referable to the time of James I., with Celtic ornamentation.

Professor Cunningham, M.D., exhibited some additional Models illustrative of Brain Growth.

Donations to the Library were announced, and thanks were voted to the Donors.

The following letter was read:—

"ROYAL INSTITUTION, EDINBURGH,
"*April 26th*, 1888.

"DEAR SIR,

"In acknowledging receipt of your letter accompanying the Diploma of Membership, permit me to express my sense of the very high honour the Royal Irish Academy has done me in electing me one of its Honorary Members in the Department of Polite Literature and Antiquities—an honour which I appreciate the more highly as coming from the Academy which has done, and is doing, so much to revive and foster the widening interest in Celtic Literature and Celtic Antiquities.

"I am, dear Sir,
"Yours very truly,
"JOSEPH ANDERSON.

"E. PERCEVAL WRIGHT,
"*Secretary, Royal Irish Academy.*"

MONDAY, MAY 28, 1888.

RIGHT HON. SIR PATRICK J. KEENAN, C.B., K.C.M.G., Vice-President, in the Chair.

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, JUNE 11, 1888.

PROFESSOR J. P. O'REILLY, Vice-President, in the Chair.

The Secretary read for the Rev. T. E. Espin "A New Edition of Birmingham's Red Star Catalogue."

By permission of the Academy, Mr. W. F. Wakeman read a Paper "On the 'Bullan,' or Rock Basin in Ireland."

Donations to the Library were announced, and thanks were voted to the Donors.

The following Science Grants, recommended by the Council, were confirmed:—

£20 to Mr. Joly, for an investigation of the Melting Points and Thermal Expansions of Minerals.

£10 to a Committee, consisting of Prof. G. F. Fitz Gerald, F.R.S.; Prof. W. J. Sollas, and Mr. Smeeth, for the purposes of investigating the Electrical Resistance of Crystals.

The Treasurer read, in accordance with By-Law 3, Chapter III., the List of Members in arrear.

MONDAY, JUNE 25, 1888.

PROFESSOR J. P. O'REILLY, Vice-President, in the Chair.

Sir George Porter, M.D.; Rev. Leonard G. Hassé; and Dr. John Lentaigne signed the Roll, and were admitted Members of the Academy.

Mr. Edward H. Earl, Mr. Wesley W. Wilson, and Mr. William E. Wilson were elected Members of the Academy.

Dr. Frazer called attention to the manufacture of Spurious Antiquities in the City of Dublin.

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, NOVEMBER 12, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

The Secretary read a Paper by Sir Robert S. Ball, LL.D., F.R.S., "Eighth Memoir on the Theory of Screws, showing how Plane Geometry Illustrates General Problems in the Dynamics of a Rigid Body, with Three Degrees of Freedom."

The Secretary read a Paper by Lieutenant-Colonel W. G. Wood-Martin, "Report on an Exploration of a Crannog Site in Meath."

The following were exhibited :—

Two Casts of Scottish Antiquities, presented by D. W. Kemp, Esq., Edinburgh.

Gold Torque, recently added to the Museum of the Academy.

Silver Coins, Hiberno-Danish, presented by the Hon. Robert Marsham.

Donations to the Library were announced, and thanks were voted to the Donors.

Letter read from the University of Bologna, thanking the Academy for sending a deputation to take part in the Eighth Centenary celebration of the University.

FRIDAY, NOVEMBER 30, 1888.

SIR ROBERT KANE, LL.D., F.R.S., in the Chair.

Mr. W. W. Wilson and Mr. L. W. King signed the Roll, and were admitted Members of the Academy.

Donations to the Library were announced, and thanks were voted to the Donors.

The following Science Grant, recommended by the Council, was confirmed :—

£30 to Professor Cunningham, M.D., to aid him in his researches on "Cranio-Cerebral Topography."

MONDAY, DECEMBER 10, 1888.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. William Edward Wilson signed the Roll, and was admitted a Member of the Academy.

The Very Rev. William (Canon) Hutch, D.D., and Brigade-Surgeon Charles Sibthorpe, F.K.Q.C.P., were elected Members of the Academy.

The Todd Professor (Rev. Bartholomew MacCarthy, D.D.), delivered the First Todd Memorial Lecture, Series III. "On the Codex Palatino-Vaticanus. No. 830."

Sir Robert Ball, LL.D., F.R.S., read a Paper on "The Harmonic Tidal Constituents of the Port of Dublin."

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, JANUARY 14, 1889..

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Edward H. Earl signed the Roll, and was admitted a Member of the Academy.

Mr. Charles Grove Young, M.D., was elected a Member of the Academy.

The Todd Professor (Rev. Bartholomew MacCarthy, D.D.) delivered the Second Todd Memorial Lecture, Series III. Subject:—"The Codex Palatino-Vaticanus. No. 830." (Successions and Synchronisms from Books of Leinster and Ballymote.)

Mr. W. J. Knowles read his "Report on the Flint Implements of the North-East of Ireland."

Mr. W. J. Knowles read his "Report on the Prehistoric Remains from the Sand-hills of the Coast of Ireland."

Mr. W. J. Knowles read a "Note on an old Iron brazed Bell from Cullybackey, Co. Antrim."

Rev. B. MacCarthy, D.D., read a "Note on the Tripartite Life of St. Patrick. New Textual Readings."

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, JANUARY 28, 1889.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Professor J. P. O'Reilly, C.E., read a Paper on "The Directions of Jointings in the Neighbourhood of Bray."

The Secretary read for Brigade-Surgeon C. Sibthorpe, F.K.Q.C.P., "Notes on Filaria sanguinis hominis."

The President called attention to an Ancient Tombstone, found in the Graveyard of All Hallows Monastery, near Rathdrum, Co. Wicklow, which had been presented to the Academy by W. F. Littledale, Esq.

Donations to the Library were announced, and thanks were voted to the Donors.

Mr. W. J. Doherty moved and Mr. George Coffey seconded the following:—

"That the Council of the Academy be recommended to prepare and print, for the use of the Members and the public, a descriptive list of all articles in the Museum of the Academy that are not enumerated in Sir William Wilde's Catalogue; and to have a complete record made and printed, for similar use, of all Irish Antiquities and other articles that are to be transferred to the Museum of Science and Art, Dublin.

Which was adopted.

MONDAY, FEBRUARY 11, 1889.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Justice O'Hagan, Vice-President, took the Chair while the President read a Paper on "Geometrical Illustrations of Newlands' and Mendelejeff's Periodic Law of the Atomic Weights of the Chemical Elements. Part III. The Fifth and Sixth Periods of Seven Elements following Hydrogen; or the Zirconium and Tin double period. Part IV. The Ninth and Tenth Periods of Seven Elements following Hydrogen; including Gold, Mercury, Bismuth, and Wolfram."

Professor Bartholomew MacCarthy, D.D., read the Third Todd Memorial Lecture, Series III. Subject—"Synchronisms from the Book of Ballymote."

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, FEBRUARY 25, 1889.

HON. MR. JUSTICE O'HAGAN, Vice-President, in the Chair.

Rev. David B. Mulcahy, P.P., signed the Roll, and was admitted a Member of the Academy.

Professor Bartholomew Mac Carthy, D.D., read the Fourth Todd Memorial Lecture, Series III. Subject—"Synchronisms from the Book of Ballymote."

Donations to the Library were announced, and thanks were voted to the Donors.

SATURDAY, MARCH 16, 1889.

(Stated Meeting.)

RIGHT HON. SIR PATRICK J. KEENAN, C.B., K.C.M.G., Vice-President, in the Chair.

The Vice-President, in the Chair, declared the Ballot open for President and Council for the ensuing year, and appointed Deputy-Surgeon-General King and Dr. Mac Swiney Scrutineers.

The Ballot was also opened for the election of Honorary Members, the Treasurer and Secretary of the Academy being appointed Scrutineers.

The Secretary of Council read the following

REPORT OF THE COUNCIL FOR THE YEAR 1888–9.

Since the date of the last Report of the Council the following Parts of the *Transactions* have been published:—

Vol. xxix.

Part 3. "On Two-nosed Catenaries and their Application to the Design of Segmental Arches." By T. Alexander, C.E., Professor of Engineering, Trinity College, Dublin; and A. W. Thomson, B.SC., Assoc. Mem. Inst., C. E., Lecturer in the Glasgow and West of Scotland Technical College.

Part 4. "The Brain and Eyeball of a Human Cyclopian Monster." By D. J. Cunningham, M.D. (Edin. and Dubl.), Professor of Anatomy, Trinity College, Dublin; and E. H. Bennett, M.D., Professor of Surgery in Trinity College, Dublin.

Part 5. "On the Theory of the Content." By Sir Robert Stawell Ball, LL.D., F.R.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland.

The following is in the Press, and will be published immediately:

Part 6. "The Tripartite Life of St. Patrick: New Textual Studies." By the Rev. B. Mac Carthy, D.D., M.R.I.A., &c.

Of the *Proceedings*, Part 1 of the first volume of Series iii. was published in December, 1888, containing Papers in the various Departments of the Academy's work, the Council having determined in the Third Series to revert to the original method of publishing Papers consecutively, instead of in separate sections of Science, Polite Literature, and Antiquities, respectively.

The contributors of Papers during the year were:—Rev. Dr. Haughton, F.R.S., President of the Academy; Professor J. Alexander, M.A.I.; Sir R. S. Ball, F.R.S.; Professor D. J. Cunningham, M.D.; Rev. T. E. Espin, M.A.; W. Frazer, F.R.C.S.I.; J. E. Gore, F.R.A.S.; Professor A. C. Haddon, M.A.; W. J. Knowles; Professor J. P. O'Reilly, C.E.; Brigade-Surgeon C. Sibthorpe; A. W. Thomson, B.SC.; W. F. Wakeman; Lieutenant-Colonel W. G. Wood-Martin; C. G. Young, M.D.; and the Todd Professor, Rev. Bartholomew Mac Carthy, D.D.

The following Grants in aid of the Preparation of Scientific Reports have been sanctioned by the Academy:—

£20 to Mr. Joly, for an investigation of the Melting Points and Thermal Expansions of Minerals.

£10 to a Committee, consisting of Prof. G. F. FitzGerald, F.R.S., Prof. W. J. Sollas, and Mr. Smeeth, for the purposes of investigating the Electrical Resistance of Crystals.

£30 to Professor Cunningham, to aid him in his researches on "Cranio-Cerebral Topography."

And the following will be submitted to the Academy at this Meeting:—

£20 to Mr. W. J. Knowles, to enable him to continue his in-

vestigation into the Prehistoric Remains of the Sand-hills of the Coast of Ireland.

£50 to Professor W. J. Sollas, to assist him in completing his Report on the Igneous Rocks of Carlingford and County Down.

£50 to Professor D. J. Cunningham, to assist him in completing his Report on Brain and Cranial Growth.

£20 to Professor O'Reilly to assist him in completing his investigations into the Chemical Constitution of the Cambrian Rocks of Bray Head.

The following are amongst the objects added to the collection in the Museum since the publication of last Annual Report :—

Gold neck torque, found in a bog-drain in Lissadrom, Co. Mayo.
Bronze axe-head and rude stone implements, from Scariff, Co. Clare.
Bronze penannular circlet, recently found in Co. Tyrone.
Bronze bracelet, *bronze fibula* (known as the *Cunningham Brooch*), and *bracelets of silver*, from the Londesborough collection.
Bronze leaf-shaped sword, from Lough-Gurr, Co. Limerick.
Ancient leather shoe, from Dromore.
Slab of wood, with intaglio designs.
Ancient and rare silver coins.
Casts from ancient Scottish sculptured stones.
Inscribed tombstone from graveyard of All-Hallow's Monastery, Rathdrum, Co. Wicklow.

In the Library a considerable amount of work has been done in continuation of the Catalogue of pamphlets and broadsides. A valuable Irish language manuscript, on vellum, has during the past year been obtained for the Library.

The Yellow Book of Lecan, the last of the great Irish MSS. which the Council propose to reproduce in *facsimile*, is now in hands; and it is hoped that a large proportion of the work will be completed in the summer of the present year.

During the present session the Rev. Dr. MacCarthy delivered the first series of his lectures as the Academy's Todd Professor.

In compliance with the request of the University of Bologna, the Academy appointed the President as Representative at the celebration of the Octo-Centenary of that University, which was held in May,

1888, and at which the President presented to the Rector of the University the Academy's Congratulatory Address.

The following Members have been elected since the 16th March, 1888:—

1. George D. Burtchaell, M.A., LL.B.
2. Edward H. Earl.
3. Very Rev. William (Canon) Hutch, D.D.
4. James A. Mahony.
5. Edward M. Sellors, M.A.
6. Brigade-Surgeon Charles Sibthorpe, F.K.Q.C.P.
7. Wesley W. Wilson, C.E.
8. William E. Wilson.
9. Charles G. Young, M.D.

We have lost by death, within the year, seven Members:—

1. William Hellier Baily, F.G.S., elected April 8, 1872.
2. Robert Clayton Browne, M.A., D.L., elected January 13, 1851.
3. Sir Benjamin J. Chapman, Bart., elected June 13, 1842.
4. Henry Freke, M.D., F.K.Q.C.P.I., elected May 10, 1847.
5. William Maunsell Hennessy, elected February 13, 1865.
6. Henry Hudson, M.D., F.K.Q.C.P.I., elected February 28, 1824.
7. John Herbert Orpen, LL.D., elected December 10, 1838.

We have also lost by death, within the year, three Honorary Members:—

In the Section of Science:—

1. Rudolf Julius Emmanuel Clausius, elected March 16, 1866.
2. Asa Gray, elected March 16, 1875.

In the Section of Polite Literature and Antiquities:—

1. James Orchard Halliwell-Phillipps, elected March 16, 1841.

William Hellier Baily was attached to the Geological Survey of Great Britain from 1844 to 1857, in which year he was appointed

Acting Palæontologist to the Irish branch of the Geological Survey, and in 1868 Demonstrator in Palæontology to the Royal College of Science for Ireland, which offices he continued to hold until his death.

He was the author of numerous Papers on subjects in his department of Natural History, the value of which was enhanced by their being illustrated so admirably by his skilful and accurate pencil.

The number of labourers in the field of Irish antiquities is so limited as to make the loss of any student of the Irish language a matter of deep regret; and in the case of Mr. Hennessy the loss is the more sensibly felt, because he was specially familiar with the early history and geography of Ireland. His knowledge was, unfortunately, not worked up permanently into a connected whole, such as would adequately represent his learning: Celtic scholars would have been grateful indeed for the heritage of an Irish Encyclopædia of archæology and geography, such as perhaps he alone could have written. But though no monumental work remains, enough is left to show clearly the range and accuracy of his scholarship.

In his publication of the "Annals of Loch Cé," and the "Chronicon Scotorum," in the Master of the Rolls' Series, he has given proofs of consummate ability and unsparing diligence, in the solution of many a knotty problem whose difficulty can only be appreciated by fellow-students: often, too, the printed work giving no adequate idea of the labour expended in attaining the desired solution.

Perhaps his most admirable piece of work, as it certainly is the most interesting, was his translation of the famous Irish Tale in the "Leabhar Breac," the Vision of Mac Conglinny, published in "Fraser's Magazine," September, 1873. It is not an exaggeration to say that this translation would of itself have placed him in the first rank of Irish scholars of the day: though wonderfully literal, it yet enables a reader to recognize the attractiveness of the original. As almost the only tale remaining to us from olden time of genuine Irish humour, it was well that it should receive admittance into the general current of literature through the excellent translation of so capable a scholar.

Other works, which need not here be mentioned, exhibit equally clearly the deep interest he took in all questions of Ireland's history and

archæology; but it would be hard indeed to estimate the influence he has indirectly exerted in Celtic studies by his advice and assistance.

It cannot be doubted that, in the general estimation of scholars, the reputation of Mr. Hennessy stood very high for the breadth and accuracy of his knowledge; but perhaps even a better claim to their kindly memory is the liberality with which he responded to requests for aid of any kind: loans of MSS., verifications of text, explanations of words or phrases, identifications of persons or localities, everything was granted with instant readiness. Perhaps there is hardly a single work on Irish literature or archæology published for a generation that does not contain a grateful acknowledgment of his generously accorded help.

It will scarcely be disputed that the removal from us of his familiar figure has taken away one of the land-marks in the history of the studies pursued in this Academy. Mr. Hennessy was, probably, the last of the older school of students who, by patient application to the blurred pages of MSS., have won their way to a knowledge of the real contents of Irish literature. His name in the future will form no unworthy pendant to those of O'Curry and O'Donovan.

Donations to the Library were announced, and thanks were voted to the Donors.

The Secretary of Council then moved the adoption of the following Recommendations from the Council:—

£20 to Mr. W. J. Knowles, to enable him to continue his Investigation into the Prehistoric Remains of the Sand-hills of the Coast of Ireland.

£50 to Professor W. J. Sollas, to assist him in completing his Report on the Igneous Rocks of Carlingford and County Down.

£50 to Professor D. J. Cunningham, to assist him in completing his Report on Brain and Cranial growth.

£20 to Professor O'Reilly, to assist him in completing his Investigations into the Chemical Constitution of the Cambrian Rocks of Bray Head.

The Recommendations were adopted.

On the Report of the Scrutineers, the Vice-President declared the following duly elected as President and Council for the ensuing year:—

PRESIDENT.

REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.

COUNCIL.

Committee of Science.

J. P. O'Reilly, C.E.
John Casey, LL.D., F.R.U.I., F.R.S.,
George Sigerson, M.D., F.R.U.I.
Charles R. C. Tichborne, LL.D.
Sir Robert Kane, LL.D., F.R.S.
Edward Perceval Wright, M.D.
Sir Robert S. Ball, LL.D., F.R.S.
V. Ball, M.A., F.R.S.
F. A. Tarleton, LL.D., F.T.C.D.
Daniel J. Cunningham, M.D.
Benjamin Williamson, M.A., F.R.S., F.T.C.D.

Committee of Polite Literature and Antiquities.

Robert Atkinson, LL.D.
Rev. Maxwell H. Close, M.A.
John Kells Ingram, LL.D., S.F.T.C.D.
William Frazer, F.R.C.S.I.
David R. Pigot, M.A.
Right Hon. Sir Patrick J. Keenan, C.B., K.C.M.G.
P. W. Joyce, LL.D.
John R. Garstin, M.A., F.S.A.
Hon. Mr. Justice O'Hagan, M.A.
John T. Gilbert, F.S.A.

On the report of the Scrutineers, the Vice-President declared the following elected Honorary Members of the Academy:—

In the Section of Science.

Dimitri Ivanovitch Mendelejeff, St. Petersburg.
Julius Sachs, Strasburg.

In the Section of Polite Literature and Antiquities.

C. F. Herbst, Copenhagen.
Edward Maunde Thompson, London.

The Ballot was then opened for the election of Officers, and on the report of the Scrutineers, the following were declared duly elected :—

TREASURER—Rev. M. H. Close, M.A.
SECRETARY—Edward Perceval Wright, M.D.
SECRETARY OF THE COUNCIL—Robert Atkinson, LL.D.
SECRETARY OF FOREIGN CORRESPONDENCE—Joseph P. O'Reilly, C.E.
LIBRARIAN—John T. Gilbert, F.S.A.
CLERK OF THE ACADEMY—Robert Macalister, LL.B.

The Academy then adjourned.

MONDAY, APRIL 8, 1889.

HON. MR. JUSTICE O'HAGAN, Vice-President, in the Chair.

Rev. John Henry Bernard, B.D., F.T.C.D., was elected a Member of the Academy.

The Secretary read a Report by Messrs. G. F. Fitz Gerald, F.R.S., and J. E. Cullum, "On the Magnetic Observations at Valentia."

A notice from Professor A. Milne Edwards was read, announcing that an International Congress of Zoologists would be held in Paris between the 5th and 10th August, 1889.

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, MAY 13, 1889.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Rev. J. H. Bernard, F.T.C.D., signed the Roll, and was admitted a Member of the Academy.

The Secretary read the Report of the Committee on the Deep-sea Dredging off the South West of Ireland.

The Secretary read a Paper by Dr. Bertram C. A. Windle, "On the Pectoral Group of Muscles."

Dr. Frazer read a Paper "On a Crozier with early Celtic Ornamentation."

The Secretary read a Report by Rev. H. W. Lett, "On the Mosses—Hepaticæ and Lichens—of the Mourne Mountain Range."

The President exhibited a number of Stone Implements from Demerara, presented to the Academy by Dr. C. G. Young, M.R.I.A.

The President, under his hand and seal, nominated the following as Vice-Presidents for 1889–90:—

The Right Hon. Sir Patrick Keenan, C.B., K.C.M.G.
The Hon. Mr. Justice O'Hagan, M.A.
Mr. Benjamin Williamson, M.A., F.R.S.
Sir Robert Stawell Ball, LL.D., F.R.S.

Dr. E. Perceval Wright was deputed to represent the Academy at the International Congress of Zoologists, to be held in Paris in August, 1889.

The following Letters were read:—

"Rosenborg Castle, Copenhagen,
"*5th May*, 1889.

"My Dear Sir,

"I have just received from you, as Secretary, the notification of the compliment which has been paid me by the Royal Irish Academy, in their having nominated me an Honorary Member.

"There are many points of contact, Antiquarian and Historic, between my country and Ireland, and I am proud to accept the honour thus so kindly given to me.

"With thanks and compliments,

"Very respectfully yours,

"C. F. Herbst.

"Ed. Perceval Wright, M.D.,
"*Secretary of the Royal Irish Academy.*"

"British Museum,
"*7th May*, 1889.

"Sir,

"I beg to thank you for your letter of the 30th April, informing me that the Royal Irish Academy has been pleased to elect me one of its Honorary Members, and forwarding the Certificate of election.

"I am most sensible of the distinction which has been conferred upon me, and would ask you to convey to your Academy the expression of my sincere thanks for this honour.

"I am, Sir,

"Your faithful servant,

"E. Maunde Thompson.

"E. Perceval Wright, Esq., m.d.,
"&c. &c. &c."

Donations to the Library and Museum were announced and thanks were voted to the Donors.

The following letter was read:—

"1, Winton-road, Dublin,
"*10th May*, 1889.

"Dear Dr. Wright,

"I request you, as Secretary of the Royal Irish Academy, to ask, in my name, the Academy's acceptance of the accompanying Biography, now completed by me, in three volumes, of their former distinguished President, Sir William Rowan Hamilton.

"I am very faithfully yours,

"R. P. Graves."

Part 6 of Vol. XXIX. of the *Transactions* ("The Tripartite Life of St. Patrick: New Textual Studies," by Rev. B. Mac Carthy, d.d.) was laid on the table.

MONDAY, MAY 27, 1889.

RIGHT HON. SIR PATRICK J. KEENAN, C.B., K.C.M.G., Vice-President, in the Chair.

Dr. Frazer read a Paper "On an Unusual form of Polished Stone Implement, with Sculptured Decorations."

The Secretary read a Report by Mr. S. A. Stewart "On the Botany of the Shannon Estuary and South Clare."

Dr. S. M. Mac Swiney exhibited a series of Drawings of Dublin Ornamental Marble Work of the last century which were presented to the Academy by Mr. Stirling Ballantine.

A special vote of thanks was passed to Mr. Stirling Ballantine for his Donation.

Donations to the Library were announced, and thanks were voted to the Donors.

The following grants, recommended by the Council, were confirmed:

£40 to Prof. G. F. Fitz Gerald, F.R.S., and Mr. E. Cullum, to assist them in carrying on a series of Magnetic Observations at Valentia.

£15 to Mr. S. A. Stewart and Mr. R. L. Praeger for an Investigation of the Flowering Plants and Characeae of the Mourne Mountain Range.

The following Letter was read:—

"ST. PETERSBURG, $\frac{30th\ April}{12th\ May}$, 1889.

"DEAR SIR,

"I beg to acknowledge the receipt of your letter, dated the 30th of April, with the Diploma accompanying it.

"Please to convey to your Society my gratitude and thanks for the honour they have conferred upon me.

"I am, dear Sir,

"Yours faithfully,

"D. MENDELEJEFF.

"ED. PERCEVAL WRIGHT, ESQ., M.D."

The Treasurer, in compliance with Section 3, Chapter III., of the By-Laws, read the List of Members in arrear.

MONDAY, JUNE 24, 1889.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Robert Barklie, F.C.S.; Mr. James Brenan, R.H.A.; and Rev. George Raphael Buick, M.A., were elected Members of the Academy.

The Secretary read a Paper by Mr. Thomas Preston, M.A., "On the Motion of a Particle and the Equilibrium of Strings on a Spherical Surface."

The Secretary read a Paper by the Lord Bishop of Limerick "On the Focal Circles of Spherical Conics."

The Secretary read a Paper by the Lord Bishop of Limerick "On an Ogham inscribed on a Tine of an Antler of an Elk or Stag found in the Crannog at Moynagh, Co. Meath."

By permission of the Academy, The Rev. Dr. Mahaffy, F.T.C.D., read a Paper "On a Relic of St. Cataldus."

By permission of the Academy, Mr. William S. M'Cay, M.A., F.T.C.D., read a Paper "On Three Similar Figures, with an Extension of Feuerbach's Theorem."

The Rev. The President read a Paper, "Prediction of the Atomic Weight of the Missing Element between Molybdenum and Silver, founded on the known Atomic Weights of the Rhodium, Ruthenium, and Palladium Groups."

The Secretary read a Paper by Dr. W. Doberck, "Observations of Double Stars made at Markree."

Donations to the Library were announced, and thanks were voted to the Donors.

A vote of thanks was passed to Mr. Owen Smith of Nobber, Co. Meath, for his donation of a Tine of an Antler of a Deer with an Ogham inscription.

The following letter was read:—

"WÜRZBURG, 30 *Mai*, 1889.

"SEHR GEEHRTER HERR!

"Die Royal Irish Academy hat mir die hohe Auszeichnung erwiesen, mich zu ihrem Ehrenmitglied zu erwählen. Ich bin durch diese Ernennung freudig überrascht und bitte Sie, dem Verehrten

Herrn Presidenten so wie der Kgl. Akademie meinen herzlichen Dank dafür aussprechen zu wollen.

"Ich ergreife diese angenehme Gelegenheit, Ihnen, Verehrter Herr College, meine besondere Hochachtung zu bezeugen.

"SACHS."

The following grant, recommended by the Council, was confirmed:

£10 to Mr. V. Ball, F.R.S., to assist him in completing his Report on the Mineral and Vegetable Substances used as drugs in India during the Middle of the 16th century.

Transactions, Vol. XXIX., Part 7 ("Geometrical Illustrations of Newlands' and Mendelejeff's Periodic Law of the Atomic Weights of the Chemical Elements," by Rev. Dr. Haughton), and Part 8 ("The Eighth Memoir on the Theory of Screws," by Sir Robert Ball), were laid on the table.

MONDAY, NOVEMBER 11, 1889.

RIGHT HON. SIR PATRICK J. KEENAN, C.B., K.C.M.G., Vice-President, in the Chair.

Mr. James Brenan, R.H.A., signed the Roll, and was admitted a Member of the Academy.

Mr. J. Casimir O'Meagher read a Paper "On St. Patrice de Rouen."

Donations to the Library were announced, and thanks were voted to the Donors.

SATURDAY, NOVEMBER 30, 1889.

(STATED MEETING.)

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

On the motion of the Secretary, seconded by the Treasurer, By-law 6, Chapter IX., was suspended (to permit the reading of Papers and the Admission of Visitors).

Dr. E. Perceval Wright reported that he had, as Representative of the Academy, attended the International Congress of Zoologists, held in Paris in the month of August.

Prof. G. F. Fitz Gerald, F.R.S., F.T.C.D., read a Paper, by Sir William Thomson, F.R.S., "On the Stability and Small Oscillation of a Perfect Liquid full of nearly Straight Coreless Vortices."

Prof. W. J. Sollas, F.R.S., read "Contributions to a Knowledge of the Granites of Leinster."

The President then presented to the Academy an Oil Portrait (by Miss Purser) of himself.

Donations to the Library and Museum were announced, and thanks were voted to the Donors.

MONDAY, DECEMBER 9, 1889.

HON. MR. JUSTICE O'HAGAN, Vice-President, in the Chair.

Mr. Mac Carthy Conner was elected a Member of the Academy.

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, JANUARY 13, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. William S. M'Cay, M.A., F.T.C.D.; Mr. Frederick Purser, M.A., F.T.C.D.; and Mr. Douglas Hyde, LL.D.; were elected Members of the Academy.

Professor O'Reilly read a "Note bearing on the History of the Irish Wolf Dog."

The Secretary read for Sir Robert Ball, F.R.S., a "Note on a Determinant in the Theory of Screws."

Dr. V. Ball, F.R.S., read as a Report "A Commentary on the Colloquies of Garcia de Orta on the Simples and Drugs of India."

Mr. G. H. Kinahan read "Notes on some Specimens of North American Indian Pottery, with Models of Bone Implements, presented to the Academy by the Hon. Edward Murphy of Montreal.

The President read a note by the Right Rev. Dr. Graves, Bishop of Limerick, "On the Theory of Surfaces of the Second Order."

Donations to the Library were announced, and thanks were voted to the Donors.

On the motion of Mr. G. H. Kinahan, seconded by Rev. Denis Murphy, S.J., a special vote of thanks was passed to the Hon. Edward Murphy for his donation of Specimens of North American Indian Pottery.

The following Science Grants, recommended by the Council, were confirmed by the Academy:—

£15 to Prof. Hartog to enable him to carry on his researches into the Physical Structure of Protoplasm.

£15 to Mr. G. Y. Dixon and Mr. A. F. Dixon to enable them to investigate the Marine Invertebrate Fauna of the neighbourhood of Dublin.

On the motion of Mr. G. H. Kinahan, seconded by Professor O'Reilly, it was resolved "That an Address of Welcome be presented to his Excellency the Lord Lieutenant, and that the Officers be requested to prepare a draft address for the approval of the Academy."

The Officers subsequently brought up the following Address, which was adopted:—

"To His Excellency Laurence, Earl of Zetland,

"*Lord Lieutenant-General and General Governor of Ireland.*

"May it please your Excellency,

"We, the President and Members of the Royal Irish Academy, desire to offer to your Excellency our respectful congratulations on your assuming the high office of Viceroy of Her Most Gracious Majesty the Queen.

"The Royal Irish Academy was incorporated by Royal Charter, more than a hundred years ago, for the purpose of promoting the study of Science, Polite Literature, and Antiquities.

"It has discharged, during that period, in Ireland, functions similar to those of the Royal Society in England, and of the Royal Society of Edinburgh in Scotland; and also to those of the Societies of Antiquaries of London and of Scotland.

"The results of the labours of the Academy in the various branches of knowledge are known through its publications, which are to be found in the chief scientific and literary centres of Europe and America.

"Your Excellency, as Viceroy, is Visitor of the Royal Irish Academy, and we trust that in the exercise of this office you will continue that protection of its interests which the Academy has received from your predecessors, and that you will, if possible, make yourself practically acquainted with the details of its work and methods."

MONDAY, JANUARY 27, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Frederick Purser, M.A., F.T.C.D., and Mr. William S. M'Cay, M.A., F.T.C.D., signed the Roll, and were admitted Members of the Academy.

Donations to the Museum and Library were announced, and thanks were voted to the Donors.

MONDAY, FEBRUARY 10, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Mr. Blayney Reynell Townley Balfour, D.L., and Rev. Edmund Hogan, S.J., were elected Members of the Academy.

Sir Robert Ball read his "Ninth Memoir on the Theory of Screws, showing a remarkable transformation of the general differential equations of Motion and other applications in the theory of Abstract Dynamics.

Professor Haddon read a Paper by Mr. W. Kitchen Parker, F.R.S, "On the Osteology of the *Alcidæ* and the *Anatidæ*.

Donations were announced, and thanks were voted to the Donors.

WEDNESDAY, FEBRUARY 12, 1890.

(SPECIAL MEETING.)

A Special Meeting of the Academy was held for the purpose of receiving His Excellency the Lord Lieutenant, Visitor of the Academy.

Their Excellencies the Lord Lieutenant and the Countess of Zetland, having been received by the Rev. Dr. Haughton, President, and the Members of the Council, were conducted to the Library,

where the Address, adopted at the Meeting on 13th January, was presented.

His Excellency replied as follows :—

"Dr. Haughton and Gentlemen—I am fully sensible of the honour that has been done me by the Members of the Royal Irish Academy, and desire to convey to them my cordial thanks for their Loyal welcome.

"I am very pleased indeed to have this opportunity of meeting so many distinguished Members of your Academy, and of inspecting your admirable collection of ancient manuscripts and Irish antiquities, of which you have such good reason to be proud.

"It would be difficult, I think, to overrate the obligations we owe this Institution for having gathered together so many splendid specimens of the ancient art of Ireland, and for the valuable contributions it has made to the early history of this country.

"The record of the original work of your Members in the fields of Literature and Science cannot fail to be most gratifying to all who have the interests of the Academy at heart, and who desire, as I cordially do, to see it continue to advance in its career of usefulness. I assure you that you may at all times count on my willingness to extend to the Academy the same support as my predecessor, and that I wish all success may attend its labours in the future."

Their Excellencies then inspected many of the Ancient Manuscripts in the Library and the Antiquities in the Museum.

MONDAY, FEBRUARY 24, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Rev. Edmund Hogan and Mr. Blayney R. T. Balfour signed the Roll, and were admitted Members of the Academy.

The following Science Grants, recommended by the Council, were confirmed :—

£85 to Sir Robert Ball, F.R.S., for a Star Photograph Measuring Apparatus.

£5 to Professor M. Hartog, PH.D., to assist him in his Researches into the Physical Structure of Protoplasm. (Additional grant.)

£15 to a Committee consisting of the President and Mr. Robert Russell, F.T.C.D., towards making Mechanical Appliances for the Graphic Construction of Quadratic, Cubic, and Quartic Curves.

The following Resolution was moved by the Right Rev. Dr. Reeves, Bishop of Down and Connor, seconded by Mr. David R. Pigot, and adopted :—

"That the Academy desires to place on record its deep sense of the great loss which it has sustained by the decease of Sir Robert Kane, LL.D., F.R.S., who had been for over fifty-eight years one of its Members, during which he had taken a very active part in the direction of its affairs as Member and Secretary of its Council, and for five years as its President."

"The Academy tenders to the members of his family its sincerest sympathy in their bereavement."

It was moved by Sir Robert Ball and seconded by Dr. Frazer—

"That the Academy, as a mark of respect to the memory of Sir Robert Kane, now adjourn ;"

which being carried, the Academy then adjourned.

SATURDAY, MARCH 15, 1890.

(Stated Meeting.)

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Rev. Robert Conlan signed the Roll, and was admitted a Member of the Academy.

The Ballot was then opened for the Election of President and Council for the ensuing year.

Mr. J. R. Garstin and Mr. J. F. Lombard were appointed Scrutineers.

The Ballot was also opened for the Election of an Honorary Member.

Dr. Davy and Professor O'Reilly were appointed Scrutineers.

The Secretary of Council then read the following:—

REPORT OF THE COUNCIL FOR THE YEAR 1889–90.

Since the date of the last Report of the Council the following parts of the *Transactions*, vol. xxix., have been published:—

Part 7. "Geometrical Illustrations of Newlands and Mendelejeff's Periodic Law of the Atomic Weights of the Chemical Elements." By the Rev. Samuel Haughton, M.D. (Dubl. et Bonon.), D.C.L. (Oxon.) LL.D. (Cantab. et Edin.), F.R.S.

Part 8. "The Eighth Memoir on the Theory of Screws, showing how Plane Geometry illustrates General Problems in the Dynamics of a Rigid Body with Three Degrees of Freedom." By Sir Robert S. Ball, LL.D., F.R.S. Plate VI.

Part 9. "The Focal Circles of Spherical Conics." By the Right Rev. Dr. Graves, Lord Bishop of Limerick, F.R.S.

Part 10. "On Three Similar Figures, with an Extension of Feuerbach's Theorem." By William S. M'Cay, M.A., F.T.C.D.

Part 11. "On the Motion of a Particle, and the Equilibrium of Flexible Strings on a Spherical Surface." By T. Preston, M.A.

Part 12. "The Pectoral Group of Muscles." By Bertram C. A. Windle, M.A., M.D.

Part 13. "Observations of Double Stars made at Markree." By W. Doberck, PH.D.

The following is in the press and will shortly be published:—

"Cunningham Memoirs." (No. V.). The Red Stars: Observations and Catalogue, by J. Birmingham. New Edition by Rev. T. E. Espin.

Of the *Proceedings*, Part 2 of the first volume of Series iii. was published in December, 1889, containing Papers in various branches of Science and Archæology, and Part 3 it is hoped will be published in May next, containing the Papers ordered for publication up to the date of the last Meeting.

The Contributors of Papers during the year were:—Rev. Dr. Haughton, F.R.S., President; Sir R. S. Ball, F.R.S.; V. Ball, F.R.S.; J. E. Cullum; W. Doberck, PH.D.; G. F. FitzGerald, F.R.S.; W. Frazer, F.R.C.S.I.; Right Rev. Dr. Graves, F.R.S.; G. H. Kinahan, F.R.G.S.I.; Rev. H. W. Lett, M.A.; W. S. M'Cay, F.T.C.D.; Rev. Dr. Mahaffy, F.T.C.D.; J. C. O'Meagher; J. P. O'Reilly, C.E.; W. Kitchen Parker, F.R.S.; T. Preston, M.A.; W. J. Sollas, F.R.S.; S. A. Stewart; Sir W. Thomson, F.R.S.; B. C. A. Windle, M.D.; E. Perceval Wright, M.D.; C. G. Young, M.D.

The following Grants in aid of the Preparation of Scientific Reports have been sanctioned by the Academy:—

£40 to Professor G. F. FitzGerald, F.R.S., and Mr. E. Cullum, to assist them in carrying on a Series of Magnetic Observations at Valentia.

£15 to Mr. S. A. Stewart and Mr. R. L. Praeger, for an Investigation of the Flowering Plants and Characeæ of the Mourne Mountain Range.

£10 to Mr. V. Ball, F.R.S., to assist him in completing his Report on the Mineral and Vegetable Substances used as Drugs in India during the Middle of the 16th Century.

£20 to Professor M. Hartog, PH.D., to enable him to carry on his researches into the Physical Structure of Protoplasm.

£15 to Mr. G. Y. Dixon, M.A., and Mr. A. F. Dixon, to enable them to investigate the Marine Invertebrate Fauna of the neighbourhood of Dublin.

£85 to Sir Robert Ball, F.R.S., for a Star Photograph Measuring Apparatus.

£15 to a committee consisting of the President and Mr. Robert Russell, F.T.C.D., towards making mechanical appliances for the Graphic Construction of Quadratic, Cubic, and Quartic Curves.

[Appended to this Report is given a list of the Grants in aid of Scientific Research voted by the Academy from June, 1879, up to the present date.]

In the Library we have received by donation an interesting set of drawings of Irish marble work of the last century. A valuable and unique series of delineations of ancient edifices in Ireland has also

been acquired, together with several important additions to the Academy's collection of tracts and pamphlets. The Government has deposited with the Academy the remainder of the collections made by the late topographical department of the Ordnance Survey of Ireland, and these will now be accessible in the Library of the Academy, with the volumes of the same collections which we received many years since.

With respect to the Irish department of the Academy's work, there have been printed off fifty-two pages of the Yellow Book of Lecan, in photography, and a large number of pages have been photographed, and are shortly to be printed off.

Dr. Atkinson has finished his edition of Keating's Tri Bior-ghaoithe an Bháis, vol. i., text, glossary, and appendix, and it will be laid before the Academy at the next Meeting.

A correspondence has taken place between His Excellency the Lord Lieutenant, Her Majesty's Treasury, and the Council, in reference to the future Housing of the Academy, after the transfer of its Museum to the New Museum of Science and Art, Dublin. The Council feel that the best thanks of the Academy are due to His Excellency for so promptly and effectually intervening as to secure to the Academy the continued occupancy of their present house.

The Council trust that the further question of the future relations of the Academy to their Museum Collections will shortly receive definite solution, upon which the transfer may be speedily effected, to the suitable apartments prepared for the Collections in the New Museum Building.

The following Members have been elected since the 16th March, 1889:—

Blayney R. T. Balfour, D.L.
Robert Barklie, F.C.S.
Rev. John H. Bernard, B.D., F.T.C.D.
James Brenan, R.H.A.
Rev. George Raphael Buick, M.A.
Mac Carthy Conner.
Rev. Edmund Hogan, S.J.
Douglas Hyde, LL.D.
William S. M'Cay, M.A., F.T.C.D.
Frederick Purser, M.A., F.T.C.D.

The following Honorary Members were elected on the 16th March of last year :—

In the Section of Science.

Dimitri Ivanovitch Mendelejeff.
Julius Sachs.

In the Section of Polite Literature and Antiquities.

Christian Frederick Herbst.
Edward Maunde Thompson.

We have lost by death within the year nine Members :—

John Ball, M.A., F.R.S., elected April 13, 1840.
Matthew P. D'Arcy, M.A., D.L., elected April 13, 1846.
Right Hon. the Earl of Granard, K.P., elected April 13, 1863.
Sir Robert Kane, M.D., LL.D., F.R.S., elected November 30, 1831
Robert Edwin Lyne, elected January 13, 1868.
Robert M'Donnell, M.D., F.R.S., elected February 9, 1857.
Walter Myers, elected April 10, 1876.
John Neville, C.E., F.R.G.S.I., elected June 8, 1844.
Thomas Williams, elected January 9, 1837.

We have also lost by death within the year one Honorary Member in the Section of Science.

Elias Loomis, elected March 16, 1880.

Among the ordinary Members removed by death we may specially mention, although not a contributor to the *Transactions* of the Academy, Mr. John Ball, F.R.S., who represented the Academy for many years on the Government Grant Committee of the Royal Society. The results of his distinguished botanical, geographical, and physical investigations are published elsewhere.

DR. ROBERT M'DONNELL was born on the 15th March, 1828, in Dublin. He entered Trinity College, Dublin, in 1844, graduating as B.A. in 1849; M.B. in 1851; and M.D. in 1857. He also studied in the Schools of Paris and Vienna. He was elected a Member of this Academy in 1857, and served for several years on its Council. In

1865 he was made a Fellow of the Royal Society, and has served on several Royal Commissions, such as those appointed to inquire into the Medical Acts, into the Prisons in Ireland, and on the Education and Employment of the Blind.

Well known and highly respected by his professional colleagues, he was President of the Royal College of Surgeons in Ireland in 1877; and was President of the Academy of Medicine in Ireland in 1885.

During the Crimean War he served as a Volunteer, being first attached to the British Hospital at Smyrna, and then at Sebastopol, receiving for his services the British Medal and clasps and the Turkish Medal.

His contributions to Surgical literature were very numerous, but in his early days, before the responsibilities and cares of a large practice were upon him, he devoted all his leisure to Physiological and Biological studies: many papers on such subjects will be found in the *Journal de la Physiologie*, and in the *Proceedings* of the Royal Dublin Society. To our *Transactions* he contributed in 1862 a Memoir on the "Lateral Line in Fishes."

Sir Robert Kane, almost from his boyhood, exhibited a very strong taste and aptitude for chemical research, and in 1828, at the early age of eighteen, published his first paper, "Observations on the Existence of Chlorine in the Native Peroxide of Manganese." This was soon followed by a number of essays on various chemical subjects. For his investigations into the chemical history of Archil and Litmus, printed in the *Philosophical Transactions*, he obtained in 1841 a Royal Medal from the Royal Society of London.

For his researches on the nature and constitution of the compounds of Ammonia he was awarded, in 1843, the Cunningham Gold Medal of this Academy. It may be mentioned in connection with his labours on those compounds, that in the opinion of Berzelius, Kane has assisted in an important degree, to establish the actual existence in nature of *amide* (or, as Kane preferred to call it, *amidogene*, from its analogy with oxygen, &c.), *i.e.* H_2N, which had been before only inferred by Dumas.

In addition to these classical researches, he made many others of considerable scientific value, amongst which may be mentioned those on Pyroxylic spirit, or Acetone; on the composition of certain essential oils; on the constitution of the Ethers; and on several new Salts, or

compounds, which he discovered, of Copper, Mercury, Platinum, and other metals. In addition to his labours in the fields of original research he published, in 1842, his "Elements of Chemistry."

Having been appointed Professor of Natural Philosophy to the Royal Dublin Society in 1843, he delivered before the Society, in that year, a series of lectures on the natural sources of wealth in this country. These constituted the basis of his well-known book published in the following year, "The Industrial Resources of Ireland," which, even in these days, notwithstanding the change of circumstances in various respects and the subsequent advancement of science, continues to be a work of great interest and importance.

In 1849 Sir R. Kane was elected a Fellow of the Royal Society.

Having been for a short time Director of the Museum of Irish Industry, Dublin, he was appointed, in 1849, the first President of Queen's College, Cork; the duties of which post he zealously and efficiently discharged until he resigned it in 1873, when he came to live in Dublin. In 1875 he was appointed Commissioner of National Education, and a Member of the Academic Council of the University of Dublin, and, in 1880, a Member of the Senate of the Royal University.

To us of the Academy his loss is great; he was emphatically one of our land-marks, his Membership of the Academy having begun so far back as 1831. He was elected on the Council in 1841; he was Secretary of the Council from 1842 to 1846, and President of the Academy from 1877 to 1882.

Along with his rare ability and scientific attainments, Sir R. Kane was endowed with qualities which made association with him very pleasant; his excellent judgment and unruffled temper made him an admirable adviser on any point on which his opinion was asked, or when he felt it his duty to set forth his views. And in consequence of his habitual moderation he was able to hold and express perfectly definite opinions without forfeiting either the friendship or the respect of those from whom he differed. Perhaps few men of his position have preserved so steadily to the end so large a circle of friends; and there are still fewer whom even opponents would name with such unfeigned esteem and respect.

It should not be forgotten that his work was in various ways pre-eminently of a national character; the result of his labours tended directly to benefit and to ameliorate the condition of his fellow-

countrymen. A thoroughly practical man, he has left an admirable example of the manner in which skilled knowledge may be made to yield valuable results for the better development of the condition and resources of a country.

The following is a list of the Papers by Sir Robert Kane in the *Transactions* and *Proceedings* of the Academy :—

Papers published in the "Transactions."

1835. "Researches on the Action of Ammonia on the Chlorides and Oxides of Mercury."
1837. "On a Series of Combinations derived from Pyro-acetic Spirit."
1837. "On the Composition of certain Essential Oils."
1838. "Researches on the Nature and Constitution of the Compounds of Ammonia."

Papers published in the "Proceedings."

1836. "Contributions to the History of Pyroxylic Spirit, and the derived Combinations."
1836. "Xanthomethilic Acid."
1836. "On the Composition of Thebaine."
1837. "Researches on the Combinations derived from Pyro-acetic Spirit."
1837. "On Dumasine, a new Fluid Substance isometric with Camphor."
1837. "On the Composition of certain Essential Oils."
1838. "On the Sulphates and Nitrates of Mercury, particularly the basic salts formed by Ammonia."
1838. "On the Theory of Ammoniacal Compounds."
1838. "On the Ammoniacal and other Basic Compounds of the Copper and Silver Families."
1838. "On the Action of Arseniuretted Hydrogen on Sulphate of Copper, and on the Manganese Alum analysed by Dr. Apjohn."
1838. "On the Theory of the Ethers."
1839. "On a Substance intermediate between White Precipitate and Sal-ammoniac."
1840. "On the Production of Audible Sounds."

1842. "On the Colouring Matter of the Persian Berries."
1842. "On the Tannin of Catechu and the Chemical Substances derived from it."
1843. "On the Chemical Composition of the different plants of Flax and Hemp."
1844. "On the Chemical Composition of the different kinds of Fuel found in Ireland."
1847. "On the Composition of the Essential Oil of *Laurus sassafras*, and of certain compounds derived from it."
1848. "Maps illustrative of the distribution of the values of land in Ireland."
1849. "On the Manufacture of Iron in this country."

APPENDIX.

PARLIAMENTARY GRANT FOR THE PREPARATION OF SCIENTIFIC REPORTS.

[*Vide* also Appendix B, Minutes of *Proceedings* for 1875, p. lxvii., and Appendix A, Minutes of *Proceedings* for 1880, p. 134.

From June, 1879, to Feb., 1890, the following Grants in aid of Scientific Research recommended by the Council have been approved of by the Academy :—

No.	Date.	Name and Subject.	Amount of Award.
	1879.		£ s. d.
76	June 23.	G. H. Kinahan, R. J. Ussher, and Leith Adams, for the exploration of the Cappagh Caves near Dungarvan, ...	50 0 0
77	„ „	J. E. Reynolds, for the purchase of a considerable quantity of Sulpho-urea, to make experiments on the Comparative Actions of the Isomeric Bodies, Sulphocyanate of Ammonium, and Sulpho-urea, on the growth of certain plants, ...	15 0 0
78	„ „	G. H. Kinahan and W. H. Baily, for the investigation of the fossils and igneous rocks of the Curlew and Fintona Beds, ...	50 0 0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award.		
	1880.		£	s.	d.
79	Jan. 26.	R. M. Barrington, for the investigation of the Flora of the Blaskett Islands, ...	10	0	0
80	,, ,,	H. C. Hart, for the investigation of the Flora of the Galtee Mountains, ...	10	0	0
81	,, ,,	P. S. Abraham, to assist him in the Microscopic Study of the Marsupial Tissues, ...	20	0	0
82	Mar. 16.	S. A. Stewart, for the exploration of the Botany of the portion of the County Fermanagh west of Lough Erne, including what is called the Highlands of Fermanagh, ...	10	0	0
83	,, ,,	J. E. Reynolds and Rev. S. Haughton, for Microscopic Slide Sections of a large collection of Sandwich Island Lavas, already analysed by Dr. Haughton, .	20	0	0
84	,, ,,	H. W. Mackintosh, for the further investigation of the Structure of Echinoderms, ...	30	16	6
85	,, ,,	F. Hodges, for researches on the action of various Bleaching Agents, ...	25	0	0
86	,, ,,	I. Carroll, for the exploration of the Botany of the district in the County Cork lying to the westward of a line drawn from Skibbereen to Bantry, ...	10	0	0
87	,, ,,	G. Sigerson, for the Construction of an Electric Apparatus for Physiological investigations, ...	20	0	0
88	,, ,,	B. C. A. Windle, for researches on the embryology of the Muscular System, ...	25	0	0
89	June 14.	E. T. Hardman, to make Soundings in Lough Gill, with a view to throwing light on the Geological Formation of the locality, ...	15	0	0
	1881.				
90	Feb. 14.	F. P. Blackwill and J. Wright, for the examination of the Foraminifera of Dublin Bay, ...	20	0	0
91	,, ,,	Gerrard Kinahan, in aid of his researches on the Chemical Impurities of River Waters, ...	30	0	0
92	,, 28.	Rev. S. Haughton, to aid in completing his researches in Sun Heat, ...	50	0	0
93	,, ,,	R. A. Hayes, to aid him in Microphotography by Electric Light, ...	10	0	0
94	,, ,,	R. M. Barrington, for the Botanical Exploration of the Islands of Lough Erne, ...	15	0	0
95	,, ,,	S. A. Stewart, to complete the investigation of the Botany of the Mountains of Fermanagh and Cavan, ...	10	0	0
96	Mar. 16.	H. C. Hart, to aid him in the Exploration of the Botany of the Killarney Mountains, ...	20	0	0
97	,, ,,	A. G. More and A. C. Haddon, for Dredging in Dublin Bay, ...	25	6	6
98	May 23.	E. W. Davy, for further researches on the Organic Nitro-prussides, ...	20	0	0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award.
	1882.		
99	Jan. 23.	T. H. Corry, for an examination of the Botany of Ben Bulben, ...	15 0 0
100	,, ,,	J. L. E. Dreyer, for Calculations to determine the exact Value of the Constant of Precession, . .	20 0 0
101	,, ,,	Rev. W. Green, towards Exploring the New Zealand Glaciers, ...	30 0 0
102	,, ,,	W. F. De Vismes Kane, for an examination of the Entomological Fauna of the wooded districts of Ulster, ...	25 0 0
103	Feb. 13.	H. W. Mackintosh, to aid in Exploring the Zoophytes of the Irish Coast, ...	20 0 0
104	,, ,,	A. G. More, to aid in the Exploration of the Botany of St. Kilda, ...	15 0 0
105	Mar. 16.	H. C. Hart, for a Botanical exploration of the Mountain Ranges of Ireland, ...	25 0 0
106	,, ,,	R. M. Barrington, to complete his Botanical exploration of the Shores and Islands of Lough Erne, .	15 0 0
107	,, ,,	S. A. Stewart, for a Botanical exploration of Rathlin,	15 0 0
108	,, ,,	Rev. W. Green, towards exploring the New Zealand Glaciers (in addition to £30 already voted), . .	17 10 11
109	June 12.	Gerrard A. Kinahan, in aid of researches in the Minerals of Ireland by means of washing, . .	25 0 0
110	,, ,,	E. W. Davy, in aid of researches in the Physical and Chemical Properties of the Alkaloids, . . .	25 0 0
111	Dec. 11.	H. C. Hart, for exploration of the Botany of the Coast-line of Ireland, ...	15 0 0
112	,, ,,	F. P. Balkwill and J. Wright in aid of further researches in the Foraminifera of Dublin Bay, . .	20 0 0
	1883.		
113	Dec. 11.	A. Macalister, to purchase Skulls of the Peninsular and Insular Races of Western Europe, for comparison with Irish Crania, ...	25 0 0
114	Feb. 26.	W. Doberck, for a Magnetic Survey of Ireland, .	50 0 0
115	,, ,,	C. A. Cameron, for researches on the Iodates and Bromates of the Alkaloids, ...	10 0 0
116	,, ,,	H. C. Hart, for the continued Botanical Examination of the Mountains of Ireland, ...	30 0 0
117	May 28.	T. H. Corry, to continue the Botanical Survey of Ben Bulben, ...	10 0 0
118	,, ,,	S. A. Stewart, for a Botanical Survey of Lough Allen and the Slievanierin Mountains, ...	15 0 0
119	,, ,,	W. F. de V. Kane, to investigate the Entomological Fauna of the South and South-west Coasts of Ireland,	25 0 0
120	,, ,,	J. Wright and F. P. Balkwill for further researches on the Foraminifera of Dublin Bay and neighbourhood,	10 0 0
121	,, ,,	Greenwood Pim, to investigate the Irish Fungi, especially those of Killarney, ...	15 0 0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award.		
	1883.		£	s.	d.
122	May 28.	Rev. H. W. Lett, for an examination of the Mosses and Lichens of the Mourne Mountains, . . .	10	0	0
123	Nov. 12	R. M. Barrington, for the exploration of the Flora of the Shannon Lakes, ...	15	0	0
124	,, ,,	R. S. Ball, for the Construction of a Model of a Cylindroid, ...	15	0	0
125	,, ,,	H. C. Hart, for a Botanical Report in connection with the Palestine Exploration Expedition, . . .	50	0	0
	1884.				
126	Feb. 11.	W. M. Coates, for a Magnetic Survey of Ireland. [A grant of £50 was made to Dr. Doberck for this purpose in February, 1883, but, being unable to proceed with the survey, in consequence of his departure to Hong Kong, he returned the amount of the grant.], ...	50	0	0
127	,, ,,	Rev. S. Haughton, to assist in defraying the expenses of Calculations of Sun-heat and Radiation, . .	35	0	0
128	,, ,,	R. M. Barrington and R. P. Vowell, to complete the Botanical Survey of the Ben Bulben Range, . .	15	0	0
129	Nov. 10.	Rev. S. Haughton, in supplement of a grant of £35, to defray the expenses of Calculation of Sun-heat Co-efficients and Radiation, ...	15	0	0
130	,, ,,	W. Adeney, for a Chemical and Spectroscopical Investigation of the rarer Elements in some of the Crystalline Rocks of Donegal, ...	25	0	0
131	,, ,,	A. C. Haddon, for researches on the Morphology of the Mollusca, ...	30	0	0
132	,, ,,	H. C. Hart, for the investigation of the Flora of Southern Donegal, ...	15	0	0
133	,, ,,	S. A. Stewart, for the investigation of the Flora of the Southern portion of the County Clare and the Shannon Estuary, ...	15	0	0
134	Dec. 8.	J. P. O'Reilly, to aid in researches regarding the Distribution of Earthquakes in Great Britain and Ireland, ...	15	0	0
135	,, ,,	W. Frazer, for the purchase of the Standard Instruments for the correct measurement of Crania, ...	10	0	0
	1885.				
136	Feb. 9.	E. P. Wright, A. C. Haddon, W. J. Sollas, H. W. Mackintosh, P. Sladen, J. Wright, and R. Malcolmson, for a report on the Deep-Sea Dredging off the Entrance to Bantry Bay, ...	50	0	0
137	,, ,,	W. J. Sollas, to aid in researches on the Metamorphic and Igneous Rocks of the Western Highlands of Ireland, ...	40	0	0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award.		
			£	s.	d.
	1885.				
138	Feb. 9.	J. Wright, to aid in researches on the Foraminifera of Dublin Bay, ...	20	0	0
139	" "	R. M. Barrington, to aid in researches as to the Migration of Birds in Ireland, ...	15	0	0
140	June 8.	R. M. Barrington and R. P. Vowell, for a report on the Flora of the Shores and Islands of Lough Ree, .	10	0	0
141	" "	H. C. Hart, for a further report on the Flora of the County of Donegal, ...	10	0	0
142	" "	W. F. de V. Kane, for a report on the Distribution of the Lepidoptera of the South of Ireland, . .	10	0	0
143	" "	W. Gray, for a report on the Worked Flints of the North-east of Ireland, ...	10	0	0
144	" "	S. A. Stewart, for a report on the Flora of the Southern Shores of the Shannon, ...	10	0	0
145	" "	A. M'Henry, for a report on the Animal and other Remains found in the Sand-hills of Ballintoy and the Crannog of Lough-na-Crannagh, ...	20	0	0
146	" "	A. G. More, for a report on the Geographical Distribution of Plants in Ireland, ...	50	0	0
147	Nov. 9.	W. J. Knowles, to investigate the Flint Implements of the North-east of Ireland, ...	10	0	0
148	" "	D. J. Cunningham, for a report on the Anatomy of the Chimpanzee, ...	60	0	0
	1886.				
149	Feb. 22.	E. P. Wright, W. J. Sollas, and A. C. Haddon, to assist in the preparation of the Record of Zoological Literature for 1885, ...	10	0	0
150	June 28.	H. C. Hart, towards the continuance of the Botanical Exploration of Southern and Central Donegal, .	15	0	0
151	" "	A. C. Haddon, Rev. W. S. Green, J. Wright, and E. P. Wright, for a further report on the Dredging in Deep Water off the South-west Coast of Ireland, .	40	0	0
	1887.				
152	Feb. 28.	G. F. FitzGerald, to aid in making Magnetic Observations at Valentia, ...	40	0	0
153	" "	J. P. O'Reilly, to aid in a Chemical Study of certain Rock Formations about Dublin, ...	15	0	0
154	" "	Rev. S. Haughton and G. F. FitzGerald, to aid in ascertaining the Amounts of Evaporation of Water and other Liquids, when the same Total Amount of Heat is applied in different times, ...	40	0	0
155	" "	W. J. Sollas, to aid in the Study of the Structures and Relations of the Igneous Rocks of the Carlingford and Mourne Mountain Districts, ...	25	0	0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award. £	s.	d.
	Feb. 28.				
156	,, ,,	V. Ball, to prepare a report on the Mineral and Vegetable Substances used as Drugs in India in the middle of the sixteenth century, ...	25	0	0
157	June 27.	Rev. T. E. Espin, to assist him in the revision of Birmingham's Red Star Catalogue, ...	10	0	0
158	,, ,,	R. P. Vowell, for the investigation of the Flora of the Shores and Neighbourhood of Loughs Corrib and Mask, ...	10	0	0
159	,, ,,	J. P. O'Reilly, as an additional grant for the investigation of the Constitution of certain Cambrian Rocks, ...	25	0	0
	1888.				
160	Jan. 23.	R. L. Praeger, for the investigation of the Post-tertiary Estuarine Deposits of the North of Ireland, . .	10	0	0
161	,, ,,	W. J. Knowles, for the investigation of the Pre-historic Remains of the Sand-hills of the Coast of the Northern Counties, ...	20	0	0
162	,, ,,	J. P. O'Reilly, as an additional grant for the investigation of the Chemical Constitution of the Cambrian Rocks of Bray, ...	15	0	0
163	Feb. 13.	A. C. Haddon, to assist him in the investigation of the Coral Reefs of Torres Straits, ...	50	0	0
164	Feb. 27.	W. G. Wood-Martin, for the Exploration of the newly-discovered Crannog Site in the County of Meath, ...	10	0	0
165	,, ,,	Rev. W. S. Green, J. Wright, C. B. Ball, and E. P. Wright, to continue the Deep-sea Investigations to the one thousand fathom depth off the South Coast of Ireland, ...	60	0	0
166	June 11.	J. Joly, for the investigation of the Melting Points and Thermal Expansion of Minerals, ...	20	0	0
167	,, ,,	G. F. FitzGerald, W. J. Sollas, and R. Smeeth, for the investigation of the Electrical Resistance of Crystals, ...	10	0	0
168	Nov. 30.	D. J. Cunningham, for researches on Cranio-Cerebral Topography, ...	30	0	0
	1889.				
169	Mar. 16.	W. J. Knowles, as an additional grant for the investigation of the Pre-historic Remains of the Sand-hills of the Coast of Ireland, ...	20	0	0
170	,, ,,	W. J. Sollas, as an additional grant for the investigation of the Igneous Rocks of Carlingford and County Down, ...	50	0	0
171	,, ,,	D. J. Cunningham, as an additional grant for researches on Brain and Cranial Growth, ...	50	0	0

PARLIAMENTARY GRANT—*continued.*

No.	Date.	Name and Subject.	Amount of Award.		
	1889.		£	s.	d.
172	Mar. 16.	J. P. O'Reilly, as an additional grant for the investigation of the Chemical Constitution of the Cambrian Rocks of Bray Head, ...	20	0	0
173	May 27.	G. F. FitzGerald and E. Cullum, to carry on a series of Magnetic Observations at Valentia, . . .	40	0	0
174	" "	S. A. Stewart and R. L. Praeger, for an investigation of the Flowering Plants and Characeæ of the Mourne Mountain Range, ...	15	0	0
175	June 24.	V. Ball, as an additional grant for the investigation of the Mineral and Vegetable Substances used as Drugs in India during the middle of the sixteenth Century, ...	10	0	0
	1890.				
176	Jan. 13.	M. Hartog, to enable him to carry on his researches into the Physical Structure of Protoplasm, . .	15	0	0
177	" "	G. Y. Dixon and A. F. Dixon, to enable them to investigate the Marine Invertebrate Fauna of the neighbourhood of Dublin, ...	15	0	0
178	Feb. 24.	Sir Robert Ball, for a Star Photograph Measuring Apparatus, ...	85	0	0
179	" "	M. Hartog, as an additional grant to assist him in his Researches into the Physical Structure of Protoplasm,	5	0	0
180	" "	Rev. Dr. Haughton and Mr. R. Russell, towards making mechanical appliances for the Graphic Construction of Quadratic, Cubic, and Quartic Curves .	15	0	0

The Report was adopted.

Read the following letter from Mr. R. R. Kane :—

"DUNGIVEN, AILESBURY ROAD,
"*March 2nd*, 1890.

"DEAR DR. WRIGHT,

"On behalf of the family of Sir Robert Kane, I desire to express our deep sense of the honour done to his memory by the resolution of the Royal Irish Academy, a copy of which you sent to me in yours of the 24th February.

"Yours very faithfully,

"ROBERT ROMNEY KANE.

"E. P. Wright, Esq., M.D."

By-Law 6, chapter ix., having been suspended, Visitors were admitted.

Professor R. Atkinson, LL.D., read a Paper on—"The use of Two Inflexional Forms of the Verb in Irish."

The Secretary read for Professor Sollas, LL.D., F.R.S., a Paper on—"The occurrence of Zinnwaldite in the Granite of the Mourne Mountains."

On the report of the Scrutineers, the President declared the following duly elected as President and Council for the ensuing year:—

PRESIDENT:

REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.

COUNCIL.

Committee of Science.

John Casey, LL.D., F.R.U.I., F.R.S.
Charles R. C. Tichborne, LL.D.
Edward Perceval Wright, M.D.
Sir Robert S. Ball, LL.D., F.R.S.
V. Ball, LL.D., F.R.S.
F. A. Tarleton, LL.D., F.T.C.D.
Daniel J. Cunningham, M.D.
Benjamin Williamson, M.A., F.R.S., F.T.C.D.
J. P. O'Reilly, C.E.
George L. Cathcart, M.A., F.T.C.D.
Rev. Joseph A. Galbraith, M.A., S.F.T.C.D.

Committee of Polite Literature and Antiquities.

Robert Atkinson, LL.D.
Rev. Maxwell H. Close, M.A.
David R. Pigot, M.A.
Right Hon. Sir Patrick J. Keenan, C.B., K.C.M.G.
P. W. Joyce, LL.D.
John R. Garstin, M.A., F.S.A.
Hon. Mr. Justice O'Hagan, M.A.
John T. Gilbert, F.S.A.
John Kells Ingram, LL.D., S.F.T.C.D.
Right Rev. William Reeves, D.D., *Bishop of Down and Connor.*

The ballot was then opened for the election of Officers. Mr. Lombard and Mr. Garstin were appointed Scrutineers.

On the motion of Deputy Surgeon-General King, seconded by Professor Atkinson, Professor E. Perceval Wright, M.D., was elected a Visitor of the Museum of Science and Art, Dublin.

On the Report of the Scrutineers, the President declared the following duly elected:—

TREASURER—Rev. M. H. Close, M.A.
SECRETARY—Edward Perceval Wright, M.D.
SECRETARY OF THE COUNCIL—Robert Atkinson, LL.D.
SECRETARY OF FOREIGN CORRESPONDENCE—Joseph P. O'Reilly, C.E.
LIBRARIAN—John T. Gilbert, F.S.A.
CLERK OF THE ACADEMY—Robert Macalister, LL.B.

On the Report of the Scrutineers, the President declared that

Sir William Turner, F.R.S.,

had been elected an Honorary Member in the Section of Science.

Donations to the Library were announced, and thanks were voted to the Donors.

The President under his hand and Seal appointed the following as Vice-Presidents for the ensuing year:—

Hon. John O'Hagan, Mr. Benjamin Williamson, Sir Robert Ball, Dr. John K. Ingram.

The Academy then adjourned.

MONDAY, APRIL 14, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Douglas Hyde, LL.D., signed the Roll, and was admitted a Member of the Academy.

Lord Walter Fitzgerald and Rev. Rowland Scriven, M.A., were elected Members of the Academy.

Professor Cunningham, M.D., read a Paper on "A Stage in the Growth of the Brain of the Order Primates."

The following letter from Sir William Turner was read:—

"6, ETON-TERRACE, EDINBURGH,
"*20th March*, 1890.

"SIR,

"I had the honour to receive this day your letter of the 18th March, with accompanying Diploma, in which you inform me that

at the Stated Meeting on the 15th instant I was elected an Honorary Member of the Royal Irish Academy in the Section of Science.

"Permit me to express my most cordial thanks to the Academy for the distinction conferred upon me in enrolling me on the list of their Honorary Members.

"It is a most unexpected honour, and is consequently the more appreciated.

"Believe me to remain

"Your obedient Servant,

"WILLIAM TURNER.

"DR. E. PERCEVAL WRIGHT,
"Secretary Royal Irish Academy."

Donations to the Library were announced and thanks were voted to the Donors.

Mr. J. Y. Robertson presented to the Academy some tracings from frescoes on the walls of St. Canice's Cathedral, Kilkenny.

A special vote of thanks was passed for this Donation.

MONDAY, APRIL 28, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

The Secretary read for Mr. Joseph Wright a Report on the Foraminifera of the South of Ireland.

Professor O'Reilly read a "Note on the Occurrence of Idocrase in the County of Monaghan."

Dr. Frazer read a "Note on two Medals of St. Vergil and St. Rudbert, Irish Missionary Saints of the Seventh Century, struck at Salzburg.

Dr. Frazer read a "Note on the Irish Remains at Lough Crew," and exhibited a series of Illustrations by the late G. V. Du Noyer of the Scribed Stones found at Lough Crew.

Donations to the Library were announced, and thanks were voted to the Donors.

A letter was read from Dr. John M'Donnell, M.R.I.A., presenting a Copy of the *Lilium Medecinae* to the Library.

A special vote of thanks was accorded to Dr. M'Donnell for this Donation.

MONDAY, MAY 12, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Rev. George Raphael Buick, M.A., signed the Roll, and was admitted a Member of the Academy.

Dixon C. O'Keefe, M.A., and Robert Lloyd Woollcombe, LL.D., were elected Members of the Academy.

Mr. Justice O'Hagan took the Chair while the President read a Paper "On the Newtonian Chemistry—1. General Principles; 2. Binary Compounds; 3. Ternary Compounds."

The Secretary read a Paper by Dr. Scharff "On some New or Rare Fishes from the South-West Coast of Ireland."

Donations to the Library were announced, and thanks were voted to the Donors.

MONDAY, JUNE 9, 1890.

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

Robert Lloyd Woollcombe, LL.D., signed the Roll and was admitted a Member of the Academy.

The Secretary read a Paper by Mr. H. C. Hart, B.A., "On the Range of Flowering Plants and Ferns on the Mountains of Ireland."

The Secretary read a Paper by Mr. J. E. Gore, F.R.A.S.—"A Catalogue of Binary Stars for which Orbits have been computed."

The Treasurer laid on the table the Audited Accounts for 1889–90, and the Estimate for 1890–91.

The Treasurer read the list of Members in arrear, as ordered by By-Law 3, chapter iii.

MONDAY, JUNE 23, 1890.

J. K. INGRAM, LL.D., S.F.T.C.D., Vice-President, in the Chair.

Rev. Rowland Scriven, M.A., signed the Roll, and was admitted a Member of the Academy.

Professor J. P. O'Reilly read a Paper "On the Occurrence of Serpentine in the Rocks of Bray Head."

Professor B. Williamson, F.R.S., F.T.C.D., read a Paper "On Curvilinear Co-ordinates."

The Secretary read for Mr. W. Percy Sladen a Report "On some Echinoderms from the South-West Coast of Ireland."

Donations to the Library were announced, and thanks were voted to the Donors.

The following grants, recommended by the Council, were approved of by the Academy:—

£20 to Messrs. R. Patterson and R. Lloyd Praeger to assist them in their Researches into the Vertebrate Portion of the Fauna of Ulster.

£10 to Mr. J. F. X. King to assist him in his Investigations into the Neuropterous Fauna of the North of Ireland.

£100 to a Committee, consisting of Prof. Cunningham, M.D., Rev. Dr. Haughton, F.R.S., and Prof. Haddon, M.A., to assist in the purchase of Anthropometrical Instruments.

Read Letter to the Council from Sir West Ridgeway, June 13, 1890, enclosing a Draft Agreement for transferring the Museum of the Academy to the Museum of Science and Art, Dublin, which Agreement had been approved of by the Council.

"We the Royal Irish Academy, incorporated by Royal Charter, considering that it has been deemed advisable for increasing the utility of the Museum, and securing both its future preservation and enlargement as a National Collection, to transfer and convey to the

Lords of the Committee of Council on Education on behalf of the public, the entire collection of antiquities, coins, and medals, together with the cabinets and glass cases in which the same are contained, if said latter be required, all belonging to the said Royal Irish Academy, with all such additions as may be hereafter received; and the said Lords of the Committee of Council on Education, having agreed to accept of this transfer on the terms and under the conditions specified below, all of which have been agreed to and approved of by the said Royal Irish Academy: Therefore, We, the said Royal Irish Academy, do now by these presents, but under the conditions and regulations after expressed and referred to, give, grant, assign, transfer, convey, and make over to and in favour of the said Lords of the Committee of Council on Education, for behoof of the public, all and whole the collection of antiquities, coins, and medals, belonging to the said Royal Irish Academy, with all such additions as may be hereafter made thereto, together with the cabinets and glass cases in which the same are contained, if such latter be required; and it is hereby expressly conditioned and declared, that the said Lords of the Committee of Council on Education shall, by acceptance hereof, be bound and obliged to retain the said collection in Ireland, in suitable apartments provided in the Science and Art Museum in Dublin, and at all times thereafter shall provide for the preservation and exhibition to the public of the collection of antiquities, coins, and medals hereby conveyed: and also it is hereby expressly conditioned and declared that the charge and custody of the said collection of antiquities, coins, and medals above transferred, shall remain with the said Royal Irish Academy, subject to such regulations and directions as may from time to time be prescribed by the said Lords of the Committee of Council on Education, but so as to leave the Royal Irish Academy as unfettered in the charge and management of the Museum as circumstances will allow: and also that the funds required to furnish the requisite means for the preservation and exhibition thereof, and to pay the salaries of the present officers of the Museum, who are to become officers of the Science and Art Department, and for the purchase of Irish Antiquities as at present voted under the existing Treasure Trove Regulations, Ireland, are to be provided by an estimate to be submitted to Parliament each year.

"In witness whereof," &c.

Whereupon it was moved by Master Pigot, seconded by the Right Rev. Dr. Reeves, Bishop of Down and Connor, and unanimously

Resolved—"That the President and Treasurer be authorized to affix the Corporate Seal of the Academy to the Instrument, the draft of which is now submitted, transferring the Museum of the Academy to the Lords of the Committee of Council on Education."

Monday, November 10, 1890.

Rev. Dr. Haughton, F.R.S., President, in the Chair.

The President mentioned that the Instrument conveying the Museum of the Academy to the Science and Art Department had been sealed and signed by the President and Treasurer of the Academy on behalf of the Academy, and had also been sealed and signed on behalf of the Science and Art Department; and that the Museum had been transferred to the Science and Art Museum, Dublin.

The Rev. G. Salmon, D.D., Provost of Trinity College, Dublin, moved, and the Very Rev. John O'Hanlon, P.P., seconded the following resolution:—

"That the Royal Irish Academy desires to place on record its deep sense of the great loss which it has sustained by the decease of the Rev. J. A. Galbraith, M.A., S.F.T.C.D., who had been over forty-five years one of its Members, during which period he had served several times on its Council, and had been a frequent contributor of scientific papers to its Meetings.

"The Academy tenders its sincerest sympathy to the members of his family in their bereavement."

The Secretary read for Professor Morgan W. Crofton, F.R.S., a Paper "On Applications of Operative Symbols."

The President exhibited and made some remarks on Two Meteoric Stones that fell in Winnabayo County, Iowa, on the 2nd May, 1890.

Donations to the Library were announced, and thanks were voted to the Donors.

SATURDAY, NOVEMBER 29, 1890.

(STATED MEETING.)

REV. DR. HAUGHTON, F.R.S., President, in the Chair.

The Ballot was opened for the election of Two Members of Council, and Mr. B. Williamson, F.R.S., and Mr. W. R. Molloy were appointed Scrutineers.

The following letter from Miss Galbraith was read:—

"46, LANSDOWNE-ROAD.

"Sir,—Will you kindly offer to the Royal Irish Academy the grateful thanks of my brothers, sisters, and myself, for the Resolution passed by them on the 10th inst.

"We shall cherish it among the memorials of our dear father.

"Yours faithfully,

"HANNAH GALBRAITH.

"*Nov. 15th.*"

The following Resolution was proposed by Mr. J. R. Garstin, D.L., seconded by Dr. F. A. Tarleton, F.T.C.D., and unanimously adopted:—

"That the Royal Irish Academy desires to place on record its sense of the loss it has sustained by the death of the Hon. John O'Hagan, M.A., who was a Member of the Academy since 1866, served on its Council, and at the time of his decease was the senior Vice-President of the Academy.

"That a copy of this Resolution be sent to the Members of his family, with an expression of the sympathy of the Academy with their sorrow."

By-Law 6, chapter ix., having been suspended, visitors were admitted.

Mr. George Coffey, B.E., read a Paper "On the Decorative Treatment of the Inscribed Figures in the Chamber of the Tumulus at New Grange, illustrated by a series of twenty photographs thereof."

Cunningham Memoir, No. vi., "On the Morphology of the Duck and the Auk Tribe," by W. Kitchen Parker, F.R.S., was laid on the table.

Donations to the Library were announced, and thanks were voted to the Donors.

On the report of the Scrutineers, the President declared Mr. George H. Kinahan and Dr. William Frazer duly elected Members of Council.

The President under his hand and seal appointed the Right Rev. Dr. Reeves, Bishop of Down, Connor, and Dromore, a Vice-President of the Academy, a vacancy having been caused by the death of the Hon. John O'Hagan.

LIST

OF THE

COUNCIL AND OFFICERS

AND

MEMBERS

OF THE

ROYAL IRISH ACADEMY:

DUBLIN,

17TH OF MARCH, 1891.

DUBLIN:
ACADEMY HOUSE, 19 DAWSON STREET.
1891

THE ROYAL IRISH ACADEMY,

A.D. 1891.

Patron:

HER MAJESTY THE QUEEN.

Visitor:

HIS EXCELLENCY THE LORD LIEUTENANT OF IRELAND.

ROYAL IRISH ACADEMY.

President:

(*First elected*, 16*th of March*, 1891.)

RIGHT REV. WILLIAM REEVES, D.D., M.B., LL.D., (Bishop of Down, Connor, and Dromore).

Vice-Presidents:

(*As nominated by the President*, 16*th of March*, 1891 : *with the dates from which they have continuously been re-appointed.*)

(1) SIR ROBERT S. BALL, LL.D., F.R.S. (1889).
(2) JOHN KELLS INGRAM, LL.D., S.F.T.C.D. (1890).
(3) REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D. (1891).
(4) JOHN RIBTON GARSTIN, M.A., F.S.A. (1891).

Council:

(*Elected* 16*th of March*, 1891.)

The Council consists of the Committees of Science and of Polite Literature and Antiquities.

Committee of Science (Eleven Members):

Elected.	
Nov., 1881	CHARLES R. C. TICHBORNE, PH.D.
„ 1883	ED. PERCEVAL WRIGHT, M.A., M.D.
Mar., 1885	SIR ROBERT STAWELL BALL, LL.D., F.R.S.
„ 1886	V. BALL, C.B., LL.D., F.R.S.
Nov., 1886	FRANCIS A. TARLETON, LL.D., F.T.C.D.
Mar., 1887	DANIEL J. CUNNINGHAM, M.D.
„ 1888	BENJAMIN WILLIAMSON, M.A., F.R.S., F.T.C.D.
„ 1889	JOSEPH P. O'REILLY, C.E.
„ 1890	GEORGE L. CATHCART, M.A., F.T.C.D.
Nov., 1890	GEORGE H. KINAHAN.
Mar., 1891	REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.

Committee of Polite Literature and Antiquities (Ten Members):

Mar., 1875	ROBERT ATKINSON, LL.D.
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„ 1884	PATRICK W. JOYCE, LL.D.
„ 1886	JOHN R. GARSTIN, M.A., F.S.A.
„ 1888	JOHN T. GILBERT, F.S.A.
„ 1889	JOHN KELLS INGRAM, LL.D., S.F.T.C.D.
Nov., 1890	WILLIAM FRAZER, F.R.C.S.I.
Mar., 1891	REV. DENIS MURPHY, S.J.

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(Elected annually by the Academy; with date of first election.)

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SECRETARY OF FOREIGN CORRESPONDENCE,	JOSEPH P. O'REILLY, C.E., (1880).
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CLERK OF THE ACADEMY, ...	ROBERT MACALISTER, LL.B. (1882).

(Appointed by the Council.)

LIBRARY CLERK AND SERJEANT-AT-MACE, MR. J. J. MACSWEENEY (1869).

Committees appointed by Council:

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MR. GILBERT.
DR. INGRAM.
MR. O'REILLY.
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Economy and House.

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DR. V. BALL.
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DR. FRAZER.
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DR. WRIGHT.

Representatives of the Royal Irish Academy on the Government Grant Committee of the Royal Society, London:

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ALEXANDER MACALISTER, M.A., M.D., F.R.S.

Representatives of the Royal Irish Academy on the Board of Visitors of the Science and Art Museum, the Natural History Collection, and the Botanic Gardens:

JOHN RIBTON GARSTIN, M.A., F.S.A., D.L.
REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.
EDWARD PERCEVAL WRIGHT, M.A., M.D.

MEMBERS OF THE ROYAL IRISH ACADEMY.

The sign * is prefixed to the names of Life Members.
The sign § indicates the Members who have contributed papers which have been published in the TRANSACTIONS of the Academy.

Date of Election.	
1843. April 10	*§Allman, George James, M.D. (Dub. and Oxon.), LL.D., F.L.S., F.R.C.S.I., F.R.SS., Lond. & Edin., Royal Medalist, Royal Society, 1873, Cunningham Medalist, Royal Irish Academy, 1878. *Ardmore, Parkstone, Dorsetshire.*
1871. June 12	*Amherst, William Amhurst Tyssen-, D.L., M.P., F.S.A., M.R.S.L. *Didlington Hall, Brandon, Norfolk.*
1873. Jan. 13	Andrews, Arthur. *Newtown House, Blackrock, Co. Dublin.*
1870. Jan. 10	*Archer, William, F.R.S., Cunningham Medalist, Royal Irish Academy, 1879. *National Library, Dublin.*
1870. April 11	Ardilaun, Right Hon. Arthur, Baron, M.A. *Ashford, Cong, Co. Galway; St. Anne's, Clontarf, Co. Dublin.*
1884. May 12	Atkinson, George Mounsey. 28 *St. Oswald's-road, West Brompton, London, S.W.*
1875. Jan. 11	ATKINSON, ROBERT, LL.D., Professor of Sanskrit and Comparative Philology, Dublin University, SECRETARY OF COUNCIL OF THE ACADEMY. *Clareville, Upper Rathmines, Co. Dublin.*
1890. Feb. 10	Balfour, Blayney Reynell Townley, D.L. *Townley Hall, Drogheda.*
1870. Jan. 10	*§Ball, Sir Robert Stawell, LL.D., F.R.S., F.R.A.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland, Cunningham Medalist, Royal Irish Academy, 1879. *The Observatory, Dunsink, Co. Dublin.*
1883. June 11	§Ball, V., C.B., LL.D., F.R.S., Director, Science and Art Museum, Dublin. 28 *Waterloo-road, Dublin.*
1842. Jan. 10	*Banks, Sir John T., K.C.B., M.D., LL.D., D.Sc., Regius Professor of Medicine, University of Dublin. 45 *Merrion-square, Dublin.*
1868. Jan. 13	*Barker, W. Oliver, M.D., M.R.C.S.E. 6 *Gardiner's-row, Dublin.*
1889. June 24	Barklie, Robert, F.C.S. *Knockmhore, Greenisland, Belfast.*

Date of Election.	
1874. May 11	Barrett, William F., F.R.S.E., Professor of Physics, Royal College of Science, Dublin. 6 *De Vesci-terrace, Kingstown.*
1884. Feb. 11	*Barrington, Richard Manliffe, M.A., LL.B. *Fassaroe, Bray.*
1886. June 28	*Barry, Rev. Edmond, P.P. *Rathcormac, Co. Cork.*
1880. Feb. 9	*Barry, Michael, M.D. 16 *Albion-street, Hyde-park, London, W.*
1880. Feb. 9	*Barter, Rev. John Berkeley. 21 *Via Assieta, Turin.*
1879. Feb. 10	*Beaney, James G., M.D. *Melbourne, Australia.*
1865. Jan. 9	*Beauchamp, Robert Henry. 25 *Fitzwilliam-square, South, Dublin.*
1884. May 12	Bell, Hamilton. 46 *North Great George's-street, Dublin.*
1863. April 27	*Belmore, Right Hon. Somerset Richard, Earl of, M.A., D.L., K.C.M.G. *Castle Coole, Enniskillen.*
1866. June 11	Bennett, Edward Hallaran, M.D., M.Ch., F.R.C.S.I., Professor of Surgery in the University of Dublin. 26 *Lower Fitzwilliam-street, Dublin.*
1889. April 8	Bernard, Rev. John Henry, B.D., F.T.C.D., Archbishop King's Lecturer in Divinity in the University of Dublin. 32 *Lower Leeson-street, Dublin.*
1887. Jan. 10	Birch, Rev. John George, M.A. *Kilfinaghty Glebe, Bunratty, Co. Clare.*
1889. June 24	Brenan, James, R.H.A. 36 *Belgrave-road, Rathmines.*
1878. May 13	Browne, John. *Drapersfield, Cookstown, Co. Tyrone.*
1886. April 12	Browne, William James, M.A. (Lond.) *Highfield, Omagh, Co. Tyrone.*
1889. June 24	Buick, Rev. George Raphael, M.A. *Cullybackey, Co. Antrim.*
1887. Jan. 10	Burbidge, Frederick William, M.A., F.L.S. 91 *Haddington-road, Dublin.*
1874. Feb. 9	Burden, Henry, M.A., M.D., M.R.C.S.E. 8 *Alfred-street, Belfast.*
1854. April 10	Burke, Sir John Bernard (Ulster), LL.D., C.B. *Tullamaine, Upper Leeson-street, Dublin.*
1888. April 9	Burtchaell, George Dames, M.A., LL.B. 51 *Morehampton-road, Dublin.*
1855. Jan. 8	*Butcher, Richard G., M.D., F.R.C.S.I., M.R.C.S.E. 19, *Lower Fitzwilliam-street, Dublin.*
1876. May 8	Byrne, William H., C.E. 2 *Mountjoy-square, Dublin.*
1873. May 12	Carlingford, Right Hon. Chichester, Baron, K.P., Lieutenant of Essex. *Ravensdale Park, Newry.*
1887. Jan. 10	Carroll, Thomas. *The Albert Institution, Glasnevin.*
1838. Feb. 12	*Carson, Rev. Joseph, D.D., Vice-Provost, Trinity College, Dublin. 18 *Fitzwilliam-place, Dublin.*

Date of Election.	
1876. Jan. 10	Carton, Richard Paul, Q.C. 35 *Rutland-square, West, Dublin.*
1883. June 11	Cartwright, Sir Henry Edmund, LL.B. 1 *Courtfield Gardens, London, S.W.*
1878. May 13	*Cathcart, George L., M.A., F.T.C.D. 106 *Lower Baggot-street, Dublin.*
1864. Jan. 11	Charlemont, Right Hon. James Molyneux, Earl of, K.P., Lieutenant of the County Tyrone. *Roxborough Castle, Moy, Co. Tyrone.*
1876. April 10	*Clarke, Rev. Francis E., M.A., M.D., LL.D., M.K.Q.C.P.I., M.R.C.S.E. *The Rectory, Boyle, Co. Roscommon.*
1867. May 13	*Close, Rev. Maxwell H., M.A., F.G.S., Treasurer of the Academy. 40 *Lower Baggot-street, Dublin.*
1885. Dec. 14	*Cochrane, Robert, C.E., Hon. Sec., Royal Society of Antiquaries of Ireland. 2 *Clapham-villas, Terenure-road, Co. Dublin.*
1886. Feb. 8	Coffey, George, B.A., B.E. 5 *Harcourt-terrace, Dublin.*
1882. Feb. 13	*Collins, Charles MacCarthy. *Union Bank of Australia, Brisbane.*
1882. June 26	*Collum, Rev. Hugh Robert, F.S.S. *Leigh Vicarage, Tonbridge, Kent.*
1885. Feb. 9	Colthurst, James, M.A., LL.D., 52 *Grand Parade, Cork.*
1882. Feb. 13	Comerford, Most Rev. Michael, D.D., Coadjutor Bishop of Kildare and Leighlin. *Rosglas, Monasterevan, Co. Kildare.*
1885. June 8	Conlan, Very Rev. Robert F., P.P. *Presbytery, Halston-street, Dublin.*
1889. Dec. 9	Conner, Maccarthy. 9 *Needham-place, Newry.*
1866. April 9	Cooper, Lieut.-Col. Edward H., Lieutenant of the County Sligo. *Markree Castle, Collooney, Co. Sligo.*
1878. June 24	Corbet, William J., M.P. *Springfarm, Delgany.*
1864. May 9	*Cotton, Charles Philip, B.A., C.E. *Ryecroft, Bray.*
1876. Apr. 10	Cox, Michael Francis, B.A., L.R.C.S.I. 45 *Stephen's-green, East, Dublin.*
1882. Feb. 13	*Cox, William Sidney, C.E. 66 *George-street, Limerick.*
1884. May 12	Cranny, John Joseph, B.A., M.D., F.R.C.S.I. 17 *Merrion-square, North, Dublin.*
1886. Jan. 11	Crawford, Robert, M.A., M.E. *Stonewold, Ballyshannon, Co. Donegal.*
1866. June 11	*Cruise, Francis R., M.D., F.K.Q.C.P.I., M.R.C.S.E. 93 *Merrion-square, West, Dublin.*
1870. Apr. 11	Cruise, Richard Joseph, 14 *Hume-street, Dublin.*

Date of Election.	
1885. Dec. 14	*§Cunningham, Daniel J., M.D., Edin. and Dub., Professor of Anatomy, University of Dublin. 43 *Fitzwilliam-place, Dublin.*
1876. Nov. 13	*Dalway, Marriott R., D.L. *Bella Hill, Carrickfergus.*
1886. June 28	Dames, Robert Staples Longworth, B.A. (Dub.) 21 *Herbert-street, Dublin.*
1853. April 11	*Davies, Francis Robert, K.J.J. *Hawthorn, Carysfort-avenue, Blackrock, Co. Dublin.*
1855. May 14	*§Davy, Edmund W., M.A., M.D., Prof. of Med. Jurisprudence, Royal College of Surgeons, Ireland. *St. Helen's, Highfield-road, Rathgar, Co. Dublin.*
1876. Jan. 10	Day, Robert, F.S.A. *Sidney-place, Cork.*
1876. Jan. 10	Deane, Sir Thomas Newenham, R.H.A., F.R.I.A.I. 3 *Upper Merrion-street, Dublin.*
1884. Feb. 11	*Delany, Very Rev. William, S.J., LL.D. *Presbytery Upper Gardiner-street, Dublin.*
1876. Jan. 10	*§Doberck, William, Ph.D. *The Observatory, Hong Kong.*
1879. June 9	*Doherty, William J., C.E., 29 *Rogerson's-quay, Dublin.*
1885. April 13	Donnelly, Most Rev. Nicholas, D.D., Bishop of Canea. 50 *Rathgar-road, Co. Dublin.*
1876. June 26	§Draper, Harry N., F.C.S. *Esterel, Temple-road, Upper Rathmines, Co. Dublin.*
1843. Jan. 9	*Drury, William Vallancey, M.D. *Bournemouth.*
1861. Feb. 11	Duncan, James Foulis, M.D., F.K.Q.C.P.I. 8 *Upper Merrion-street, Dublin.*
1888. June 25	Earl, Edward H. *Toronto, Canada.*
1867. Feb. 11	Ellis, George, M.B., F.R.C.S.I. 91 *Lower Leeson-street, Dublin.*
1841. April 12	*Emly, Right Hon. William, Baron, Lieutenant of the County Limerick, Vice-Chancellor of the Royal University of Ireland. *Tervoe, Limerick.*
1891. Jan. 12	*Ewart, Lavens Mathewson. *Glenbank House, Ballysillan, Belfast.*
1867. April 8	*Farrell, Thomas A., M.A. 37 *Merrion-square, East.*
1891. Jan. 12	Ffrench, Rev. James F. M. *Ballyredmond House, Clonegal, Co. Carlow.*
1878. Feb. 11	FitzGerald, George F., M.A., F.T.C.D., F.R.S., Erasmus Smith's Professor of Natural and Experimental Philosophy in the University of Dublin. 40 *Trinity College, Dublin.*
1890. April 14	Fitzgerald, Lord Walter. *Kilkea Castle, Mageney, Co. Kildare.*

Date of Election.	
1887. Jan. 10	*FitzPatrick, Louis, M.R.C.S., L.R.C.S. Ed. *Queenheyan, New South Wales.*
1875. Jan. 11	FitzPatrick, William John, LL.D., F.S.A. 49 *Fitzwilliam-square, West, Dublin.*
1876. Feb. 14	Fottrell, George. 8 *North Great George's street, Dublin.*
1866. May 14	*Frazer, William, F.R.C.S.I. 20 *Harcourt-street, Dublin.*
1865. April 10	Freeland, John, M.D. *Antigua, West Indies.*
1873. April 14	*Frost, James. *Ballymorris, Cratloe, Co. Clare.*
1875. June 14	Furlong, Nicholas, M.D. *Lymington, Enniscorthy.*
1859. Jan. 10	Gages, Alphonse, Chev. L.H. *Royal College of Science, Dublin.*
1878. May 13	Galloway, Robert, F.C.S. 60 *Pembridge Villas, Bayswater, London, W.*
1880. June 28	Gannon, John Patrick. *Laragh, Maynooth, Co. Kildare,*
1863. Feb. 9	*Garstin, John Ribton, M.A., LL.B., F.S.A., F.R. Hist. Soc., Hon. F.R.I.A.I., D.L. *Braganstown, Castlebellingham, Co. Louth.*
1855. April 9	*GILBERT, JOHN THOMAS, F.S.A., R.H.A., Cunningham Medalist, Royal Irish Academy, 1862, LIBRARIAN OF THE ACADEMY. *Villa Nova, Blackrock, Co. Dublin.*
1876. May 8	Gillespie, William. *Racefield House, Kingstown, Co. Dublin.*
1885. June 22	Goodman, Rev. James, M.A., Professor of Irish, University of Dublin. *Trinity College, Dublin.*
1875. April 12	*Gore, John Ellard, C.E., A.I.C.E., F.R.A.S. *Beltra, Ballysodare, Co. Sligo.*
1836. May 25	*Gough, Right Hon. George S., Viscount, M.A., D.L., F.L.S., F.G.S. *St. Helen's, Booterstown, Co. Dublin*
1848. June 12	*Graham, Andrew, M.A. *Observatory, Cambridge.*
1876. April 10	Grainger, Rev. John (Canon), D.D. *Broughshane, Co. Antrim.*
1837. April 24	*§Graves, Right Rev. Charles, D.D., D.C.L., F.R.S., Lord Bishop of Limerick. *The Palace, Henry-street, Limerick.*
1887. June 27	Gray, Richard Armstrong, C.E., M.I.C.E.I. *Fortfield House, Upper Rathmines.*
1874. Feb. 9	Gray, William. 8 *Mount-Charles, Belfast.*
1887. May 9	Green, James C.S., M.B. *Kamptee, India.*
1867. April 8	Green, James Sullivan, Q.C. 83 *Lower Leeson-street, Dublin.*

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Date of Election.	
1882. Dec. 11	Greer, Thomas. *Grove House, Regent's-park, London, N.W.*
1887. Jan. 10	§Gwynn, Rev. John, D.D., Regius Professor of Divinity, University of Dublin. *Thorndale, Temple-road, Upper Rathmines.*
1884. Jan. 14	Haddon, Alfred Cort, M.A., F.Z.S., Professor of Zoology in the Royal College of Science for Ireland. 13 *Palmerston-road, Rathmines, Co. Dublin.*
1875. Jan. 11	Hamilton, Edward, M.D., F.R.C.S.I. 120 *Stephen's-green, West, Dublin.*
1879. Dec. 8	Hamilton, Edwin, M.A. 26 *Stephen's-green, North.*
1886. May 10	Hassé, Rev. Leonard G. 2 *Belgrave-terrace, Rathmines, Co. Dublin.*
1861. May 13	*Hatchell, John, M.A., D.L. *Fortfield House, Terenure, County Dublin.*
1845. Feb. 24	*§Haughton, Rev. Samuel, M.A., M.D. (Dub. and Bonon.), D.C.L. (Oxon.), LL.D. (Cantab. and Edin.), F.R.S., F.G.S., F.K.Q.C.P.I., Honorary F.R.C.S.I., S.F.T.C.D., Cunningham Medalist. Royal Irish Academy, 1848. 12 *Northbrook-road, Dublin.*
1852. April 12	*Head, Henry H., M.D., F.K.Q.C.P.I., F.R.C.S.I. 7 *Fitzwilliam-square, East, Dublin.*
1888. Feb. 13	Healy, Most Rev. John, DD., LL.D., Coadjutor Bishop of Clonfert. *Palmerston House, Portumna, Co. Galway.*
1851. Jan. 13	*§Hennessy, Henry, F.R.S., Professor of Applied Mathematics and Mechanics in the Royal College of Science for Ireland. *Brookvale House, Donnybrook, Co. Dublin.*
1873. Jan. 13	Hickie, James Francis, Lieut.-Col., *Slevoyre, Borrisokane, Co. Tipperary.*
1875. Jan. 11	*Hill, Arthur, B.E., F.R.I.B.A. 22 *George's-street, Cork.*
1867. Feb. 11	Hill, John, C.E. *County Surveyor's Office, Ennis, Co. Clare.*
1888. Feb. 13	Hill, Richard Cotton Walker. 7 *Grantham-street, Dublin.*
1881. May 9	Hillis, John David, M.D., F.R.C.S.I. 134 *Leinster-road, Rathmines, Co. Dublin.*
1890. Feb. 10	Hogan, Rev. Edmund, S.J. *University College, Stephen's-green, South, Dublin.*
1888. Dec. 10	*Hutch, Very Rev. William (Canon), D.D., President of St. Colman's College. *St. Colman's College, Fermoy.*

Date of Election.	
1866. June 11	Hutton, Thomas Maxwell, D.L. 118 *Summer-hill, Dublin*
1890. Jan. 13	*Hyde, Douglas, LL.D. *Frenchpark, Co. Roscommon.*
1847. Jan. 11	*Ingram, John Kells, LL.D., S.F.T.C.D. 38 *Upper Mount-street, Dublin.*
1879. April 14	Ingram, Thomas Dunbar, LL.D. 13 *Wellington-road, Dublin.*
1873. Dec. 8	*Iveagh, Right Hon. Edward Cecil, Baron, M.A., D.L., 80 *Stephen's-green, South, Dublin.*
1867. April 8	*Jephson, Robert H. 18 *Lansdowne-road, Dublin.*
1863. Jan. 12	*Joyce, Patrick Weston, LL.D. *Lyre na Grena, Leinster-road, Rathmines, Co. Dublin.*
1878. May 13	*Kane, John F. *Leeson-park House, Dublin.*
1873. Dec. 8	*Kane, Robert Romney, M.A. *Fitzwilliam-place, Dublin.*
1865. April 10	Kane, William Francis De Vismes, M.A. *Sloperton Lodge, Kingstown.*
1870. June 13	*Keane, John P., C.E., Engineer, Public Works Department, Bengal. *Calcutta.*
1864. Nov. 14	*Keenan, Right Hon. Sir Patrick J., C.B., K.C.M.G., Resident Commissioner, Board of National Education, Ireland. *Delville, Glasnevin, Co. Dublin.*
1870. May 23	*Kelly, John, L.M. (Dub.). *University College Hospital, Calcutta.*
1846. April 13	*Kennedy, James Birch. *Cara, by Killarney.*
1866. April 9	*Kinahan, Sir Edward Hudson Hudson-, Bart., 11 *Merrion-square, North, Dublin.*
1868. Jan. 13	Kinahan, George Henry. *Woodlands, Fairview, Co. Dublin.*
1863. April 13	*Kinahan, Thomas W., M.A. 24 *Waterloo-road, Dublin.*
1883. April 9	King, Henry, M.A. M.B., Deputy Surgeon-General. 52 *Lansdowne-road, Dublin.*
1885. Dec. 14	King, Lucas White, LL.B. *Ajmere, India.*
1883. Feb. 12	Knott, John Freeman, M.A., M.D., F.R.C.S.I. 34 *York-street, Dublin.*
1883. Dec. 10	Knowles, W. J. *Flixton-place, Ballymena.*
1837. Feb. 13	*§Knox, George J., M.A. 27 *Portland-terrace, Regent's Park, London, N.W.*
1864. April 11	*Lalor, John J. *City Hall, Cork-hill, Dublin.*
1864. Jan. 11	*LaTouche, J. J. Digges, M.A. LL.D. 1 *Ely-place, Upper, Dublin.*

Date of Election.	
1857. April 13	*Leach, Lieut.-Colonel George A., R.E. 6 *Wetherby Gardens, South Kensington, London, S.W.*
1845. Feb. 10	*LeFanu, William R., C.E. *Summerhill, Enniskerry, Co. Wicklow.*
1876. Feb 14	*Leinster, His Grace Gerald, Duke of. *Carton, Maynooth.*
1869. April 12	*Lenihan, Maurice. *Limerick.*
1886. June 28	Lentaigne, John Vincent, B.A. (Dub.), F.R.C.S.I. L.K.Q.C.P.I. 29 *Westland-row, Dublin.*
1870. June 13	Leonard, Hugh, F.G.S. 2 *Herbert-terrace, Blackrock, Co. Dublin.*
1868. April 27	*Little, James, M.D., L.R.C.S.I., F.K.Q.C.P.I. 14 *Stephen's-green, North, Dublin.*
1875. April 12	Lombard, James F. *South-hill, Rathmines, Co. Dublin.*
1883. Feb. 12	Longfield, Thomas H., F.S.A. 19 *Harcourt-street, Dublin.*
1878. Feb. 11	*Lowry, Robert William, B.A. (Oxon.) D.L. *Pomeroy House, Pomeroy, Co. Tyrone.*
1873. April 14	§Macalister, Alexander, M.A. (Cantab.), M.D. (Dub. and Cantab.), F.R.S., F.S.A., Fellow of St. John's College, and Professor of Anatomy in the University of Cambridge. *Torrisdale, Cambridge.*
1871. Feb. 13	*Macartney, J. W. Ellison, D.L. *The Palace, Clogher.*
1884. May 12	§*MacCarthy, Rev. Bartholomew, D.D. *Nelson-place, Youghal, Co. Cork.*
1890. Jan. 13	§McCay, William S., M.A., F.T.C.D. *Trinity College, Dublin.*
1874. Feb. 9	McClure, Rev. Edmund, M.A., Secretary, Society for Promoting Christian Knowledge. *Northumberland-avenue, London, W.C.*
1873. Jan. 13	*McCready, Rev. Christopher, M.A. 56 *High-street, Dublin.*
1864. April 11	*McDonnell, Alexander, M.A., C.E. *Saltwell Hall, Gateshead-on-Tyne.*
1827. Mar. 16	*MacDonnell, John, M.D., F.R.C.S.I. 32 *Upper Fitzwilliam-street, Dublin.*
1882. Feb. 13	McHenry, Alexander, Geologist, Geological Survey of Ireland, 59 *Tritonville-rd. Sandymount, Co. Dublin.*
1881. Feb. 14	§Mackintosh, Henry William, M.A., Professor of Zoology and Comparative Anatomy in the University of Dublin. *Trinity College, Dublin.*
1871. April 10	Macnaghten, Colonel Sir Francis Edmund, Bart., Lieutenant of Co. Antrim. *Dundarave, Bushmills, Co. Antrim.*

Date of Election.	
1884. Jan. 14	McTernan, Rev. Stephen, P.P. *Killasnet, Manorhamilton, Co. Leitrim.*
1882. April 10	Mahony, Richard John, B.A. (Oxon.) D.L. *Dromore Castle, Kenmare, Co. Kerry.*
1874. Feb. 9	§Malet, John Christian, M.A., F.R.S., Cunningham Medalist, Royal Irish Academy, 1885, Assistant Commissioner, Intermediate Education Board for Ireland. 1 *Hume-street, Dublin.*
1865. April 10	*Malone, Rev. Sylvester, P.P., *Clare Castle, Co. Clare.*
1879. Feb. 10	Meldon, Austin, M.D., D.L. 15 *Merrion-square, North, Dublin.*
1887. Dec. 12	Milligan, Seaton Forrest. 1 *Royal-terrace, Belfast.*
1884. May 12	*Molloy, William Robert. 17 *Brookfield-terrace, Donnybrook.*
1887. Jan. 10	Moore, Frederick W. *Royal Botanic Gardens, Glasnevin.*
1861. Jan. 14	Monck, Right Hon. Charles Stanley, Viscount, G.C.M.G., Lieutenant of Dublin City and County. *Charleville, Bray, Co. Wicklow.*
1869. Feb. 8	*Moran, His Eminence Patrick F., Cardinal, D.D., Archbishop of Sydney. *New South Wales.*
1866. April 9	*More, Alexander Goodman, F.L.S., F.R.S.E. 74 *Leinster-road, Rathmines, Co. Dublin.*
1874. Feb. 9	§Moss, Richard J., F.C.S., F.I.C. *St. Aubyns, Ballybrack, Co. Dublin.*
1888. Feb. 13	*Mulcahy, Rev. David B., P.P. *Moyarget, Co. Antrim.*
1887. Nov. 14	Mulhall, John. *Viceregal Lodge, Dublin.*
1884. May 12	*Murphy, Rev. Denis, S.J. *Milltown Park, Co. Dublin.*
1887. May 9	*Nichols, Albert Russell, B.A. (Cantab.) *Science and Art Museum, Dublin.*
1873. Jan. 13	Nolan, Joseph, Senior Geologist, Geological Survey of Ireland. 2 *Clyde-terrace, St. John's-road, Sandymount, Co. Dublin.*
1846. Jan. 12	*Nugent, Arthur R. *Leamington.*
1887. Dec. 12	O'Brien, Rev. F., P.P. *Cappoquin, Co. Waterford.*
1869. June 14	*O'Brien, James H. *St. Ita's, Newtownpark, Blackrock, Co. Dublin.*
1875. Jan. 11	O'Callaghan, J. J., F.R.I.A.I. 16 *Nassau-street, Dublin.*
1867. June 10	O'Conor Don, Right Hon. The, D.L. *Granite Hall, Kingstown.*

Date of Election.	
1867. Jan. 14	O'Donel, Charles J. 47 *Lower Leeson-street, Dublin.*
1865. April 10	*O'Donnavan, William J., LL.D. 79 *Kenilworth-square, Rathgar, Co. Dublin.*
1869. April 12	O'Ferrall, Ambrose More, D.L. *Balyna House, Enfield, Co. Kildare.*
1866. Jan. 8	*O'Grady, Edward S., B.A., M.B., M. Ch., F.R.C.S.I. 33 *Merrion-square, Dublin.*
1869. April 12	O'Hanlon, Very Rev. John (Canon), P.P. *Sandymount, Co. Dublin.*
1878. Feb. 11	O'Hanlon, Michael, L.K.Q.C.P.I. *Castlecomer, Co. Kilkenny.*
1890. May 12	O'Keefe, Dixon C., M.A. *Richmond House, Templemore, Co. Tipperary.*
1869. April 12	*O'Laverty, Rev. James, P.P. *Holywood, Co. Down.*
1876. Feb. 14	Olden, Rev. Thomas, M.A. *Ballyclough Vicarage, Mallow, Co. Cork.*
1871. April 10	O'Looney, Brian, F.R.H.S. *Grove-villa House, Crumlin, Co. Dublin.*
1884. May 12	O'Meagher, Joseph Casimir. 45 *Mountjoy-square, Dublin.*
1882. Nov. 13	O'Reardon, John Frazer. 2 *Martello-terrace, Kingstown, Co. Dublin.*
1886. April 12	*O'Reilly, Henry Thomas, F.R.C.S.I. 58 *Park-avenue, Sandymount, Co. Dublin.*
1870. Jan. 10	*§O'REILLY, JOSEPH P., C.E., Prof. of Mining and Mineralogy, Royal College of Science, Dublin, SECRETARY OF FOREIGN CORRESPONDENCE OF THE ACADEMY. 58 *Park-avenue, Sandymount, Co. Dublin.*
1879. May 12	O'Rorke, Very Rev. Terence, D.D., P.P. *Collooney, Co. Sligo.*
1866. Jan. 8	*O'Sullivan, Daniel, Ph. D. 3 *Longford-terrace, Kingstown.*
1873. Feb. 10.	Patterson, William Hugh. *Garranard, Strandtown, Co. Down.*
1884. Feb. 11	Pearsall, William Booth, F.R.C.S.I. 13 *Upper Merrion-street, Dublin.*
1847. Feb. 8	*Pereira, Rev. Henry Wall, M.A., F.S.A. Scot. *Wells, Somerset.*
1863. April 13	*Pigot, David R., M.A., Master, Court of Exchequer. *Churchtown House, Dundrum, Co. Dublin.*
1870. April 11	Pigot, Thomas F., C.E., Prof. of Descriptive Geometry, Royal College of Science, Dublin. 41 *Upper Mount-street, Dublin.*

Date of Election.	
1886. Feb. 8	Pim, Greenwood, M.A. *Easton Lodge, Monkstown, Co. Dublin.*
1884. Feb. 11	Plunkett, George Noble, Count of the Roman States. 26 *Upper Fitzwilliam-street, Dublin.*
1880. Feb. 9	Plunkett, Thomas. *Enniskillen.*
1862. April 14	*Porte, George. 43 *Great Brunswick-street, Dublin.*
1873. Jan. 13	*Porter, Alexander, M.D., F.R.C.S., Indian Army. *Madras.*
1875. Jan. 11	Porter, Sir George Hornidge, Bart., M.D., M.Ch., Surgeon in Ordinary to the Queen in Ireland. 3 *Merrion-square, North, Dublin.*
1873. Jan. 13	Powell, George Denniston, M.D., L.R.C.S.I. 76 *Upper Leeson-street, Dublin.*
1875. April 12	*Powerscourt, Right Hon. Mervyn, Viscount, K.P. *Powerscourt, Enniskerry, Bray.*
1874. Dec. 14	*Purcell, Mathew John. *Stephen's-green Club, Dublin.*
1890. Jan. 13	Purser, Frederick, M.A., F.T.C.D. *Rathmines Castle, Co. Dublin.*
1858. Jan. 11	Purser, John, M.A., D.Sc., LL.D (Edin.), Professor of Mathematics, Queen's College, Belfast. *Queen's College, Belfast.*
1884. June 23	Purser, Louis Claude, M.A., F.T.C.D. 11 *Harcourt-terrace.*
1881. April 11	*Quinlan, Francis John Boxwell, B.A, M.D., F.K.Q.C.P.I. 29 *Lower Fitzwilliam-street, Dublin.*
1884. May 12	Ramsay, Edward P., F.L.S., C.M.Z.S., Curator of the Australian Museum. *Sydney, Australia.*
1867. Jan. 14	*Read, John M., General, U.S. Army; Consul-General of the U. S. A. for France and Algeria, Member of American Philoso. Soc., Fellow of the Royal Soc. of Northern Antiquaries. *Athens.*
1846. Dec. 14	*§REEVES, RIGHT REV. WILLIAM, D.D., M.B., LL.D. (Dub. and Edin.), Lord Bishop of Down, Connor, and Dromore, PRESIDENT OF THE ACADEMY, Cunningham Medalist, Royal Irish Academy. 1858. *Conway House, Dunmurry, Co. Antrim.*
1878. June 24	*Reynell, Rev. William A., B.D. 8 *Henrietta-street, Dublin.*
1881. Jan. 10	Robinson, John L., C.E. M.R.I.A.I. *Rathruadh, Glenageary, Co. Dublin.*
1876. Jan. 10	*Ross, Rev. William M.A. 163 *Hill-street, W., Glasgow.*

Date of Election.	
1870. Nov. 30	Rosse, Right Hon. Lawrence, Earl of, K.P., D.C.L., D.L., F.R.S. F.R.A.S., Chancellor of the University of Dublin. *Birr Castle, Parsonstown.*
1885. Dec. 14	*Rylands, Thomas Glazebrook, F.S.A., F.R.A.S., F.C.S. *Highfields, Thelwall, near Warrington.*
1843. Jan. 9	*§Salmon, Rev. George, D.D. (Dub. and Edin.), D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., and Royal Medalist, 1868, Copley Medalist, 1889, Royal Society, Cunningham Medalist, Royal Irish Academy, 1858, Provost of Trinity College. *Provost's House, Trinity College, Dublin.*
1853. Jan. 10	*Sanders, Gilbert. *Albany Grove, Monkstown, Co. Dublin.*
1884. Dec. 8	Sankey, Lieutenant-General Richard H., C.B., R.E., 68 *Merrion-square, Dublin.*
1888. Feb. 13	Scharff, Robert F., B.Sc., Ph.D., Curator, Natural History Department, Science and Art Museum, Dublin. 22 *Leeson-park, Dublin.*
1890. April 14	*Scriven, Rev. Rowland, M.A. (Cantab.) 33 *Stephen's-green, Dublin.*
1888. April 9	*Sellors, Edward Marmaduke, M.A. 45 *Percy-place, Dublin.*
1887. June 13	*Semple, James Charles. 64 *Grosvenor-road, Rathgar, Co. Dublin.*
1846. Feb. 9	*Sherrard, James Corry. 7 *Oxford-square, Hyde-park, London.*
1888. Dec. 11	*Sibthorpe, Charles, F.K.Q.C.P., Brigade Surgeon, Professor of Surgery, Madras Medical College. *Madras.*
1877. Dec. 10	*Smith, Charles. *Harpenden, St. Alban's.*
1868. Jan. 13	Smith, John Chaloner, C.E., *Engineer's Office, Dublin, Wicklow, and Wexford Railway, Bray.*
1891. Feb. 9	Smith, Joseph. 121 *Bewsey-terrace, Bewsey-road, Warrington.*
1876. June 26	Smith, Rev. Richard Travers (Canon), D.D. *The Vicarage, Clyde-road, Dublin.*
1887. Jan. 10	§Sollas, William Johnson, M.A., D. Sc. (Cantab), LL.D. (Dub.), Professor of Geology, University of Dublin. *Talbot House, Merrion-avenue, Blackrock, Co. Dublin.*
1891. Feb. 9	*Stokes, Rev. George Thomas, D.D., Professor of Ecclesiastical History in the University of Dublin. *All Saints' Vicarage, Blackrock, Co. Dublin.*
1871. June 12	§Stokes, Whitley, LL.D., C.S.I., Cunningham Medalist, Royal Irish Academy, 1862. 15 *Grenville-place, Cornwall Gardens, London, S. W.*

Date of Election.	
1857. June 8	*§Stoney, Bindon B., M.A., LL.D., C.E., F.R.S., 14 *Elgin-road, Dublin.*
1856. April 14	*§Stoney, George Johnstone, M.A., D.Sc., F.R.S., 9 *Palmerston-park, Upper Rathmines.*
1871. Jan. 9	Symons, John. 198 *Coltman-street, Hull.*
1877. April 9	§Tarleton, Francis Alexander, LL.D., F.T.C.D., Professor of Natural Philosophy, University of Dublin. 24 *Upper Leeson-street, Dublin.*
1869. April 12	§Tichborne, Charles Roger C., Ph.D., LL.D., F.C.S. 15 *North Great George's-street, Dublin.*
1876. April 10	*Tyrrell, George Gerald, Clerk of the Crown, Co. Armagh. 30 *Upper Pembroke-street, Dublin.*
1870 Nov. 30	Ventry, Right Hon. Dayrolles Blakeney, Baron, D.L. *Burnham, Dingle, Co. Kerry.*
1888. Feb. 13	Walpole, George. *Windsor Lodge, Monkstown, Co. Dublin.*
1884. May 12	Walsh, Most Rev. William J., D.D., Lord Archbishop of Dublin. *Archbishop's House, Drumcondra-road, Dublin.*
1881. Feb. 14	*Ward, Francis Davis. *Clonaver, Strandtown, Co. Down.*
1864. Feb. 8	*Warren, James W., M.A. 39 *Rutland-square, West, Dublin.*
1881. Jan. 10	*Watts, Robert George, M.D., F.R.S.L., *Albion House, Quadrant-road, Canonbury, London, N.*
1866. April 9	Westropp, W. H. Stacpoole, L.R.C.S.I., F.R.G.S.I., *Lisdoonvarna, Co. Clare.*
1880. Feb. 9	*White, John Newsom. *Rocklands, Waterford.*
1851. Jan. 13	*Whittle, Ewing, M.D., M.R.C.S.E. 1 *Parliament-terrace, Liverpool.*
1874. June 8	Wigham, John R. 35 *Capel-street, Dublin.*
1873. April 14	Wilkinson, Thomas. *Enniscorthy, Co. Wexford.*
1839. Jan. 14	*Williams, Richard Palmer. 38 *Dame-street, Dublin.*
1877. April 9	§Williamson, Benjamin, M.A., F.R.S., F.T.C.D. 1 *Dartmouth-road, Dublin.*
1888. June 25	*Wilson, Wesley William, C.E. *St. James's-gate, Dublin.*
1888. June 25	*Wilson, William Edward. *Daramona, Streete, Edgeworthstown.*
1884. May 12	Wood-Martin, Lieutenant-Colonel William Gregory, D.L. *Cleveragh, Sligo.*

Date of Election.	
1890. May 12	*Woollcombe, Robert Lloyd, M.A., LL.D. (Dublin Univ.), LL.D. (Royal Univ.), F.S.S., F.R.S.A. (Ireland). 14 *Waterloo-road, Dublin.*
1857. Aug. 24	*§Wright, Edward Perceval, M.A., M.D. (Dub.), M.A. (Oxon.), F.L.S., F.R.C.S.I., Cunningham Medalist, Royal Irish Academy, 1883, Professor of Botany and Keeper of the Herbarium, University of Dublin, Secretary of the Academy. 5 *Trinity College.*
1889. Jan. 14	*Young, Charles Grove, M.D. *New Amsterdam, Berbice, British Guiana.*

HONORARY MEMBERS.

Date of Election.	
1863. June 22	HIS ROYAL HIGHNESS ALBERT EDWARD, PRINCE OF WALES, K.G., K.T., K.P.

"*The* PRESIDENT OF THE ROYAL SOCIETY, AND EX-PRESIDENTS *of the same, are always considered Honorary Members of the Academy.*"—By-Laws, ii., 14.

1869. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Hooker, Sir Joseph Dalton, K.C.S.I., M.D., C.B., F.R.S., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Kew, London, W.*
1832. Nov. 30 (Elected Hon. Mem. in Sec. of Science originally.)	Airy, Sir George Biddell, K.C.B., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Playford, near Ipswich.*
1874. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Huxley, Thomas Henry, D.C.L., LL.D., M.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *London.*
1873. Mar. 15 (Elected Hon. Mem. in Sec. of Science originally.)	Stokes, Sir George Gabriel, Bart., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Cambridge.*
1878. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Thomson, Sir William, D.C.L., LL.D., PRESIDENT OF THE ROYAL SOCIETY. *Glasgow.*

SECTION OF SCIENCE.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

1873. Mar. 15	Adams, John Couch, LL.D. (Dub.), F.R.S. *Cambridge.*
1874. Mar. 16	Berthelot, Marcelin Pierre Eugène, Hon. F.R.S. *Paris.*
1875. Mar. 16	Bertrand, Joseph Louis François, Hon. F.R.S. *Paris.*
1869. Mar. 16	Brown-Séquard, Charles Édouard, M.D., LL.D. (Cantab.), F.R.S. *Paris*
1869. Mar. 16	Bunsen, Robert Wilhelm Eberard, Hon. F.R.S. *Heidelberg.*
1869. Mar. 16	Carus, J. Victor. *Leipzig.*
1873. Mar. 15	Cayley, Arthur, D.C.L., LL.D. (Dub.), F.R.S. *Cambridge.*
1883. Mar. 16	Charcot, J. *Paris.*

HONORARY MEMBERS—*Continued.*

SECTION OF SCIENCE—Continued.

Date of Election.	
1873. Mar. 15	Dana, James Dwight, LL.D., Hon. F.R.S. *New Haven, U. S. A.*
1869. Mar. 16	Daubrée, Gabriel Auguste, Hon. F.R.S. *Paris.*
1876. Mar. 16	DeCandolle, Alphonse, Hon. F.R.S. *Geneva.*
1886. Mar. 16	Frankland, Edward, M.D., D.C.L., LL.D., F.R.S. *Reigate, Surrey.*
1876. Mar. 16	Haeckel, Ernst. *Jena.*
1864. Mar. 16	Helmholtz, Hermann Ludwig Ferdinand Von, Hon. F.R.S. *Berlin.*
1884. Mar. 15	Hermite, Charles, Hon. F.R.S. *Paris.*
1873. Mar. 15	Hofmann, August Wilhelm Von, F.R.S. *Berlin.*
1879. Mar. 16	Huggins, William, D.C.L., LL.D., F.R.S. *London.*
1864. Mar. 16	Hyrtl, Karl Joseph. *Vienna.*
1880. Mar. 16	Marsh, O. C. *New Haven, U. S. A.*
1889. Mar. 16	Mendeleeff, Dimitri Ivanovitch. *St. Petersburg.*
1882. Mar. 16	Newcomb, Simon, Hon. F.R.S. *Washington.*
1884. Mar. 16	Nordenskjöld, Baron Adolf Erik de. *Stockholm.*
1878. Mar. 16	Pasteur, Louis, Hon. F.R.S. *Paris.*
1886. Mar. 16	Rayleigh, Rt. Hon. John William, Baron, M.A., D.C.L., LL.D., F.R.S., *Witham, Essex.*
1889. Mar. 16	Sachs, Julius Von, F.R.S. *Würzburg.*
1885. Mar. 16	Sylvester, James Joseph, D.C.L., LL.D., F.R.S., *Oxford.*
1890. Mar. 16	Turner, Sir William, M.B., LL.D., F.R.S. *Edinburgh.*
1882. Mar. 16	Virchow, Rudolph, Hon. F.R.S. *Berlin.*
1885. Mar. 16	Williamson, Alexander William, LL.D., F.R.S., *Haslemere, Surrey.*

(*One vacancy.*)

SECTION OF POLITE LITERATURE & ANTIQUITIES.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

Date of Election.	
1888. Mar. 16	Anderson, Joseph, LL.D. *Edinburgh.*
1882. Mar. 16	Ascoli, Graziadio I. *Milan.*
1869. Mar. 16	Benavides, Don Antonio. *Madrid.*
1882. Mar. 16	Bond, Edward Augustus, C.B., LL.D. *London.*
1848. Nov. 30	Botta, Paul Emile. *Paris.*
1882. Mar. 16	Brugsch, Pasha, Heinrich. *Berlin.*
1891, Mar. 16	Delisle, Léopold. *Paris.*
1867. Mar. 16	De Rossi, Commendatore Giovanni Battista. *Rome.*
1883. Mar. 16	Evans, John, LL.D., D.C.L., F.R.S., *London.*
1880. Mar. 16	Fick, F. C. Augustus. *Göttingen.*
1875. Mar. 16	Franks, Augustus Wollaston, M.A., C.B., F.R.S., F.S.A. *London,*
1869. Mar. 16	Gayangos y Arce, Don Pascual de. *London.*
1889. Mar. 16	Herbst, Christian Frederick. *Copenhagen.*
1878. Mar. 16	Kern, H. *Leyden.*
1854. Mar. 16	Maury, Louis Ferdinand Alfred. *Paris.*
1869. Mar. 16	Mommsen, Theodor. *Berlin.*
1863. Mar. 16	Müller, Max, M.A. *Oxford.*
1878. Mar. 16	Newton, Sir Charles, K.C.B., D.C.L., F.S.A. *London.*
1873. Mar. 15	Nigra, His Excellency Cavaliere Constantino. *St. Petersburg.*
1891. Mar. 16	Sayce, Rev. Archibald Henry, M.A., LL.D. *Oxford.*
1884. Mar. 15	Stephens, George. *Copenhagen.*
1876. Mar. 16	Stokes, Margaret. *Dublin.*
1876. Mar. 16	Stubbs, Right Rev. William, D.D., LL.D., Lord Bishop of Oxford. *Oxford.*
1889. Mar. 16	Thompson, Edward Maunde, D.C.L., LL.D., F.S.A. *London.*
1867. Mar. 16	Visconti, Barone Commendatore P. E. *Rome.*
1873. Mar. 15	Westwood, John Obadiah, F.S.A. *Oxford.*
1875. Mar. 16	Whitney, William Dwight. *New Haven, U.S.A.*
1876. Mar. 16	Windisch, Ernst. *Leipzig.*
	(Two vacancies.)

Names of Persons to whom the Cunningham Gold Medals have been Awarded.

Year.	Name.	Year.	Name.
1796	Wallace, Thomas	1858	Salmon, George
1800	Swift, Theophilus	1858	Wall, Charles William
1805	Preston, William	1858	Reeves, William
1818	Brinkley, John	1862	Lloyd, Humphrey
1827	D'Alton, John	1862	Malet, Robert
1830	Petrie, George	1862	Stokes, Whitley
1833	Petrie, George	1862	Gilbert, John Thomas
1834	Hamilton, Sir Wm. Rowan	1873	Wilde, Sir William R. W.
1838	MacCullagh, James	1878	Smith, Aquilla
1839	Apjohn, James	1878	Casey, John
1839	Petrie, George	1878	Dowden, Edward
1843	Kane, Sir Robert	1878	Allman, George James
1848	Hamilton, Sir Wm. Rowan	1879	Archer, William
1848	Haughton, Samuel	1879	Ball, Robert Stawell
1848	Hincks, Edward	1881	Grubb, Howard
1848	O'Donovan, John	1883	Wright, Edward Perceval
1851	Jellett, John Hewitt	1884	Birmingham, John
1858	Cooper, Edward J.	1885	Malet, John Christian

APPENDIX.

PRESIDENTS AND OTHER OFFICERS OF THE ROYAL IRISH ACADEMY, FROM 1785 TO 1891.

I.—PRESIDENTS.

II.—TREASURERS.

III.—SECRETARIES OF THE ACADEMY.

IV.—SECRETARIES OF THE COUNCIL.

V.—LIBRARIANS.

VI.—SECRETARIES OF FOREIGN CORRESPONDENCE.

APPENDIX.

PRESIDENTS AND OTHER OFFICERS OF THE ROYAL IRISH ACADEMY, FROM 1785 TO 1891.

I.—PRESIDENTS.

Date of Election.	
1785. May 2	Charlemont, Right Hon. The Earl of, LL.D., F.R.S. (*a*)
1799. Oct. 26	Kirwan, Richard, LL.D., F.R.S. (*b*)
1812. June 22	Charleville, Right Hon. The Earl of, (*c*)
1822. Mar. 16	Brinkley, Right Rev. John, D.D., F.R.S. (*d*)
1835. Nov. 9	Lloyd, Rev. Bartholomew, D.D. (*e*)
1837. Dec. 11	Hamilton, Sir William Rowan, LL.D., D.C.L. (*f*)
1846. Mar. 16	Lloyd, Rev. Humphrey, D.D., F.R.S., S.F.T.C.D. (*g*)
1851. Mar. 15	Robinson, Rev. Thomas Romney, D.D., LL.D., D.C.L., F.R.S. (*h*)
1856. Mar. 15	Todd, Rev. James Henthorn, D.D., S.F.T.C.D. (*i*)
1861. Mar. 16	Graves, Very Rev. Charles, D.D., F.R.S., S.F.T.C.D. (*j*)
1866. Mar. 16	Malahide, Right Hon. Lord Talbot de, LL.D., F.R.S. (*k*)
1869. Nov. 30	Jellett, Rev. John Hewitt, D.D., S.F.T.C.D. (*l*)
1874. Mar. 16	Stokes, William, M.D., LL.D., D.C.L., F.R.S. (*m*)
1877. Mar. 16	Kane, Sir Robert, M.D., LL.D., F.R.S. (*n*)
1882. Mar. 16	Ferguson, Sir Samuel, LL.D., Q.C. (*o*)
1886. Nov. 8	Haughton, Rev. Samuel, M.D., D.C.L., LL.D., F.R.S., S.F.T.C.D.
1891. Mar. 16	**Reeves, Right Rev. William, D.D., M.B., LL.D.** (*p*)

(*a*) Died, 1799, while President of the Academy. (*b*) Died, 1812, while President of the Academy. (*c*) Died, 1835. (*d*) Bishop of Cloyne, 1829; died, 1835, while President of the Academy. (*e*) Provost of Trinity College, Dublin, 1831; died, 1837, while President of the Academy. (*f*) Astronomer Royal for Ireland; died, 1865. (*g*) Provost of Trinity College, Dublin; died, 1881. (*h*) Died 1882. (*i*) Died, 1869. (*j*) Dean of the Chapel Royal, Dublin, 1860; Bishop of Limerick, 1866. (*k*) Died, 1883. (*l*) Provost of Trinity College, 1881; died, 1888. (*m*) Died, 1878. (*n*) President of Queen's College, Cork, 1850–1873; died, 1890. (*o*) Died, 1886, while President of the Academy. (*p*) Dean of Armagh, 1875; Bishop of Down, and Connor, and Dromore, 1886.

II.—TREASURERS.

Date of Election.	
1785. May 2	Conyngham, Right Hon. Wiliam Burton, M.P. (*a*)
1796. Nov. 5	Blaquiere, Colonel James.
1803. Mar. 16	Shaw, Robert.
1806. May 12	Guinness, Samuel.
1806. May 29	Hill, Colonel Hugh.
1810. Mar. 16	Prior, Rev. Thomas, D.D., F.T.C.D. (*b*)
1817. Mar. 15	Brooke, William, M.D. (*c*)
1829. July 27	Orpen, Thomas Herbert, M.D. (*d*)
1841. Nov. 30	Smith, Aquilla, M.D. (*e*)
1842. Mar. 16	Pim, James. (*f*)
1844. April 8	Ball, Robert, LL.D. (*g*)
1857. April 27	Carson, Rev. Joseph, D.D., F.T.C.D. (*h*)
1867. May 27	Hardinge, William Henry. (*i*)
1871. Mar. 16	Garstin, John Ribton, M.A.
1878. Nov. 30	**Close, Rev. Maxwell Henry, M.A.**

(*a*) Died, 1796. (*b*) Vice-Provost of Trinity College, Dublin, 1840; died, 1843. (*c*) Died, 1829. (*d*) Died, 1846. (*e*) Died, 1890. (*f*) Died, 1856. (*g*) Died, 1857. (*h*) Vice-Provost of Trinity College, Dublin, 1890. (*i*) Died, 1871.

III.—SECRETARIES OF THE ACADEMY.*

Date of Election.	
1785. May 2	Perceval, Robert, M.D. (*a*)
1789. Mar. 16	Stack, Rev. John, M.A., F.T.C.D. (*b*)
1791. June 11	M'Nevin, William James, M.D. (*c*)
1792. Mar. 16	Hall, Rev. George, D.D. (*d*)
1794. Mar. 15	Burrowes, Rev. Robert, D.D., F.T.C.D. (*e*)
1796. Mar. 16	Elrington, Rev. Thomas, D.D., F.T.C.D. (*f*)
1802. Mar. 15	Miller, Rev. George, D.D., F.T.C.D. (*g*)
1805. Mar. 16	Preston, William. (*h*)
1807. Feb. 26	Davenport, Rev. William, D.D., F.T.C.D. (*i*)
1816. Mar. 16	Singer, Rev. Joseph Henderson, D.D., F.T.C.D. (*k*)
1842. May 9	MacCullagh, James, LL.D., F.T.C.D. (*l*)
1846. Mar. 16	Todd, Rev. James Henthorn, D.D., F.T.C.D. (*m*)
1856. Mar. 18	Graves, Rev. Charles, D.D., F.R.S., F.T.C.D. (*n*)
1861. Mar. 16	Reeves, Rev. William, M.B., D.D. (*o*)
1867. Mar. 16	Sullivan, William, Kirby, Ph.D. (*p*)
1874. Mar. 16	Wright, Edward Perceval, M.A., M.D. (*q*)
1877. June 25	Ball, Sir Robert Stawell, LL.D., F.R.S. (*r*)
1880. June 28	Macalister, Alexander, M.D., F.R.S. (*s*)
1883. Nov. 30	**Wright, Edward Perceval, M.A., M.D.** (*q*)

(*a*) Died, 1839. (*b*) Died, 1813. (*c*) Died, 1841. (*d*) Provost of Trinity College, Dublin, 1806; Bishop of Dromore, 1811; died, 1811. (*e*) Died, 1841. (*f*) Provost of Trinity College, 1811; Bishop of Limerick, 1820; Bishop of Leighlin and Ferns, 1822; died, 1835. (*g*) Died, 1848. (*h*) Died, 1807. (*i*) Died, 1824. (*k*) Bishop of Meath, 1852; died, 1866. (*l*) Died, 1847. (*m*) President of the Academy 1856–1861; died, 1862. (*n*) Dean of the Chapel Royal, Dublin, 1860; Bishop of Limerick, 1866; President of the Academy, 1861–1866. (*o*) Dean of Armagh, 1875; Bishop of Down and Connor, and Dromore, 1886; President of the Academy, 1891. (*p*) President of Queen's College, Cork, 1873; died, 1890. (*q*) Professor of Botany, University of Dubln, 1869. (*r*) Astronomer Royal for Ireland. (*s*) Fellow of St. John's College, and Professor of Anatomy in the University of Cambridge, 1883.

* By the Charter [enrolled January 28, 1786], Robert Perceval, Doctor of Physic was declared "to be the first and modern Secretary to the Academy." A resolution was passed by the Academy, on November 23, 1799: "That there shall be two Secretaries of the Royal Irish Academy, who shall attend all meetings of the Academy and Council." *See* "Secretaries of the Council."

IV.—SECRETARIES OF THE COUNCIL.*

Date of Election.	
1800. Mar. 15	Miller, Rev. George, D.D., F.T.C.D. (*a*)
1802. Mar. 16	Preston, William. (*b*)
1805. Mar. 16	Stephens, Rev. Walter.
1806. Mar. 15	Davenport, Rev. William, M.A., F.T.C.D. (*c*)
1807. Feb. 23	Kyle, Rev. Samuel, D.D., S.F.T.C.D. (*d*)
1814. Mar. 16	Singer, Rev. Joseph Henderson, D.D., F.T.C.D. (*e*)
1816. Mar. 16	Sadlier, Rev. Franc, D.D., S.F.T.C.D. (*f*)
1829. July 27	MacDonnell, Rev. Richard, D.D., S.F.T.C.D. (*g*)
1838. Mar. 16	Lloyd, Rev. Humphrey, D.D., F.R.S., F.T.C.D. (*h*)
1840. Mar. 16	MacCullagh, James, LL.D., F.T.C.D. (*i*)
1842. May 9	Kane, Sir Robert, M.D., F.R.S. (*j*)
1846. Mar. 16	Graves, Rev. Charles, D.D., F.R.S., F.T.C.D. (*k*)
1854. Mar. 16	Jellett, Rev. John Hewitt, M.A., F.T.C.D. (*l*)
1860. Feb. 13	Ingram, John Kells, LL.D., F.T.C.D. (*m*)
1878. Mar. 16	**Atkinson, Robert, LL.D.** (*n*)

(*a*) Died, 1848. (*b*) Died, 1807. (*c*) Died, 1824. (*d*) Provost of Trinity College, Dublin; Bishop of Cork, 1831; died, 1848. (*e*) Bishop of Meath 1852; died, 1866. (*f*) Provost of Trinity College, Dublin, 1837; died, 1851. (*g*) Provost of Trinity College, Dublin, 1852; died, 1867. (*h*) Provost of Trinity College, Dublin, 1867; President of the Academy, 1846–1851; died, 1881. (*i*) Died, 1847. (*j*) President of Queen's College, Cork, 1850–1873; President of the Academy, 1877–1882; died, 1890. (*k*) Dean of the Chapel Royal, Dublin, 1860; President of the Academy, 1861–1866; Bishop of Limerick, 1866. (*l*) Provost of Trinity College, 1881; President of the Academy, 1869–1874; died, 1888. (*m*) Regius Professor of Greek, University of Dublin, 1866; Librarian, Trinity College, 1879. (*n*) Professor of Sanscrit and Comparative Philology in the University of Dublin, 1871.

* A resolution was passed by the Academy on November 23, 1799: "That there shall be two Secretaries of the Royal Irish Academy, who shall attend all meetings of the Academy and Council." *See* "SECRETARIES OF THE ACADEMY."

V.—LIBRARIANS.

Date of Election.	
1788. Mar. 15	Beaufort, Rev. Daniel Augustus, LL.D. (*a*)
1791. Mar. 16	Kirwan, Richard, LL.D., F.R.S. (*b*)
1800. Mar. 15	Davenport, Rev. William, M.A., F.T.C.D. (*c*)
1806. Mar. 14	Stephens, Rev. Walter.
1808. Dec. 19	Prior, Rev. Thomas, D.D., F.T.C.D. (*d*)
1810. Mar. 16	Brooke, William, M.D. (*e*)
1817. Mar. 16	Robinson, Rev. Thomas Romney. M.A., F.T.C.D., F.R.S. (*f*)
1822. Mar. 16	Drummond, Rev. William Hamilton, D.D. (*g*)
1861. Mar. 16	Gilbert, John Thomas.
1876. Mar. 16	Atkinson, Robert, LL.D. (*h*)
1878. Mar. 16	Gilbert, John Thomas, F.S.A.
1887. Mar. 16	Frazer, William, F.R.C.S.I.
1888. Mar. 16	**Gilbert, John Thomas, F.S.A.**

(*a*) Died, 1831. (*b*) President of the Academy, 1799–1812; died, 1812. (*c*) Died, 1824. (*d*) Vice-Provost, Trinity College, Dublin, 1840; died, 1843. (*e*) Died, 1829. (*f*) President of the Academy, 1851–1856; died, 1882. (*g*) Died, 1865. (*h*) Professor of Sanscrit and Comparative Philology in the University of Dublin, 1871.

VI.—SECRETARIES OF FOREIGN CORRESPONDENCE.

Date of Election.	
1785. May 2	Ussher, Rev. Henry, D.D., F.T.C.D. (*a*)
1790. June 26	Graydon, Rev. George, LL.B.
1791. Mar. 16	Perceval, Robert, M.D. (*b*)
1792. Mar. 16	Graydon, Rev. George, LL.B.
1803. Mar. 16	Hill, Colonel Hugh.
1811. Mar. 16	Hill, Colonel Edward.
1828. Nov. 29	Betham, Sir William. (*c*)
1839. May 27	MacCullagh, James, LL.D., F.T.C.D. (*d*)
1840. Mar. 16	Lloyd, Rev. Humphrey, D.D., F.R.S., F.T.C.D. (*e*)
1846. Mar. 16	Butcher. Rev. Samuel, M.A., F.T.C.D. (*f*)
1856. Mar. 16	Wilde, William Robert Wills. (*g*)
1858. Dec. 13	Butcher, Rev. Samuel, D.D., F.T.C.D. (*f*)
1864. Mar. 16	Wilde, Sir William Robert Wills, M.D. (*g*)
1874. Mar. 16	M'Donnell, Robert, M.D., F.R.S. (*h*)
1875. Mar. 16	Archer, William, F.R.S. (*i*)
1879. Mar. 15	**O'Reilly, Joseph P., C.E.** (*k*)

(*a*) Died, 1790. (*b*) Secretary of the Academy, 1785–1789; died, March, 1839. (*c*) Died, 1853. (*d*) Died, 1847. (*e*) Provost of Trinity College, Dublin, 1867; President of the Academy, 1846–1851; died, 1881. (*f*) Bishop of Meath, 1866; died, 1876. (*g*) Died, 1876. (*h*) Died, 1889. (*i*) Librarian, National Library of Ireland. (*k*) Professor of Mining and Mineralogy, Royal College of Science for Ireland.

Should any errors or omissions be found in this List, which is revised to 17th March, 1891, it is requested that notice thereof may be given to the Secretary of the Academy. He should also be informed of the death of any Member.

R. D. WEBB & SON, PRINTERS, DUBLIN.